

LAMS-2532 (Vol. II)

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**LOS ALAMOS SCIENTIFIC LABORATORY**  
**THE UNIVERSITY OF CALIFORNIA • LOS ALAMOS NEW MEXICO**

MANHATTAN DISTRICT HISTORY

PROJECT Y

THE LOS ALAMOS PROJECT

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**MANHATTAN DISTRICT HISTORY  
PROJECT Y  
THE LOS ALAMOS PROJECT**

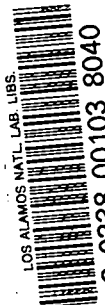
**VOL. II. AUGUST 1945 THROUGH DECEMBER 1946**

by

Edith C. Truslow  
and  
Ralph Carlisle Smith

**Contract W-7405-ENG. 36 with the U. S. Atomic Energy Commission**

This LAMS report has been prepared because of the demand for and interest in the historical information. The two volumes have not been edited except for classification purposes nor verified for accuracy. All LAMS reports express the views of the authors as of the time they were written and do not necessarily reflect the opinions of the Los Alamos Scientific Laboratory or the final opinion of the authors on the subject.







## ABSTRACT

These two volumes constitute a record of the technical, administrative, and policy-making activities of the Los Alamos Project (Project Y) from its inception under the Manhattan District through the development of the atomic bomb (Vol. I), and during the period following the end of World War II until the Manhattan District relinquished control to the Atomic Energy Commission as of January 1947 (Vol. II).

Although security regulations have required some deletions in the original text of the two volumes, every effort has been made to retain the original language and expressions of the authors.



## PREFACE

The technical history for Project Y, from its inception until August 1945, has been recorded in LAMS-2532, Vol. I. It is the purpose of this work to present the activities of the Los Alamos Laboratory from August 1945 until the end of December 1946, when the Manhattan District relinquished its control. No attempt has been made to interpret events, or to forecast the importance of scientific developments during this period. This book is merely a chronicle of the reorganization, philosophy, and subsequent achievements which transpired in this critical interim period following the cessation of hostilities.

When a cross reference is made to material within this volume, the paragraph number is in parentheses. When reference is made to Vol. I, this is so indicated.

Historical material for this supplement came from the Director, Dr. N. E. Bradbury; the Administrative Associate Director, Lt. Col. A. W. Betts; the seven Technical Division Leaders: Carson Mark, J. M. B. Kellogg, Marshall Holloway, Eric Jette, Max Roy, R. W. Henderson, and Ralph Carlisle Smith. Further assistance was rendered by J. F. Mullaney, Report Editor, and A. E. Dyhre, Business Manager. The various division Progress Reports were consulted frequently to maintain the chronological order of events, and the central files were extensively used for documentary material.

15 October 1947



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## SUMMARY BY CHAPTERS

### I. General and Technical Review

With the close of hostilities and the absence of national legislation on atomic energy, the Los Alamos Laboratory and Manhattan Engineer District were suddenly faced with the problem of determining a policy for a laboratory previously concerned with the production of an atomic weapon as soon as possible to end World War II. Personnel problems existed which were not only difficult to surmount, but in many cases were insolvable because of the mental attitude of the nuclear scientists relative to a weapon production organization. At that time, the Laboratory staff could be divided into five groups:

- (a) Academic personnel on leave from universities and colleges
- (b) Young Ph.D.'s recently from graduate school
- (c) Graduate students with varying experience
- (d) Technicians, administrative, and clerical
- (e) Officers and enlisted personnel of the Army and Navy

The attitudes of these individuals were as varied as their backgrounds. Some wished to remain at Los Alamos, but were committed to other positions. Others were indifferent to the Laboratory's future after victory was won. And as the technical and administrative future of the project was unclear, others preferred not to gamble on the outcome.

Opinions, as to the future policy for Los Alamos, varied as much as the types of persons. One school of thought suggested the Laboratory should become a monument; another group felt that it should conduct only peaceful research and abandon the atomic weapon; still a third group held that the design and production of atomic weapons must be continued.

During this transition period, Dr. J. Robert Oppenheimer relinquished direction of the Laboratory and in October 1945 Dr. N. E. Bradbury assumed this position.

Dr. Bradbury's philosophy for this interim period was one based on

the assumption that Los Alamos would continue as an operating laboratory at its original site, and that both research and development on the weapon or matters related thereto would be considered on both a short and long range. In these respects, this policy was generally approved and instituted by General L. R. Groves.

Plans were then established to build a strong permanent staff, and in so doing, the previous policy of paying the way home of Laboratory personnel upon termination was discontinued, thereby creating the expected result of forcing the personnel to a decision of staying or leaving. Those who stayed were by that act committed to working for the success of the project.

In lieu of an immediate policy, various programs were introduced as a stimulus.

The Los Alamos University was begun in September 1945 to give a program of lectures for junior Laboratory personnel. Approximately 700 took advantage of this schedule and about 130 earned college credit for their work.

Although members of the senior personnel left Los Alamos during the year after V-J Day, the Laboratory called upon a number of these to serve in a consultant status to aid the permanent staff in their problems.

Various conferences were held during 1946, some highly classified. The University Affiliation Conference held in July 1946 brought university representatives to Los Alamos to consider the possibilities offered at the Laboratory for training graduate students. The climax of this conference program was reached in August 1946, when 57 consultants met with staff members of all the Manhattan Engineer District laboratories and discussed the technical program.

The Health and Safety program went forward with increasing emphasis, but in spite of this, two serious radiation accidents occurred in August 1945 and May 1946, resulting in the death of Harry K. Daghlian and Louis Slotin.

The water shortage which developed during the winter of 1945-1946 deserves special mention because it climaxed the resentment of many against the temporary nature and operation of the community and undoubtedly inspired or at least accelerated the exodus of many personnel.

The technical organization was reorganized into seven divisions, each of which was under the leadership of an individual with extensive previous experience at Los Alamos. Besides these technical divisions, there were certain technical staff groups and an administrative division. In November 1946, the Technical Board and Weapons Panel Board were formed to aid the director.

Weapon engineering continued to improve the over-all design of the bomb. During the war, engineering had been conducted at Los Alamos and field testing at Wendover Field Utah. In the fall of 1945, this latter activity was transferred to Oxnard Field, now known as Sandia Base, near Albuquerque,

New Mexico.

Full scale high explosive production was transferred from Los Alamos to Inyokern.

In connection with the weapon program, the Laboratory undertook the technical direction of the Crossroads Operation at Bikini in the Pacific. The Joint Task Force was to conduct three types of tests using the same type of weapon employed at Nagasaki. Dr. Ralph A. Sawyer was selected Technical Director with Dr. Marshall Holloway and Roger Warner as assistants. The responsibilities of the Laboratory included recommendations for the over-all character of the test; to prepare an account of expected phenomena; to estimate the equivalent high explosive yield; to prepare the firing circuits for the underwater test as well as timing system; to prepare the weapons. Two ships were assigned Los Alamos personnel for their operations, and a regular C-54 run was established between Santa Fe and Washington for close liaison.

Operation Crossroads cost the Laboratory approximately one million dollars, as well as the time of about one-eighth of the staff, but it gave the Laboratory gains in psychological and technical values that were inestimable.

## II. Administrative Organization

For some time a strengthening of the administrative organization had been indicated. To this end Dr. Oppenheimer appointed Col. L. E. Seeman as Associate Director in charge of a new Administration and Services division. This newly formed division brought together these various groups: Administration, Personnel, Shops, Procurement, Technical Area Maintenance, and Safety. But it in no way affected the technical staff groups that continued to be directly responsible to the Director. These were: Editorial, History, Patent, Health, Library, and Declassification. The formation of the Documentary Division, in August 1946, combined all these technical staff groups except the Health Group.

The Business Office was, of course, unaffected and continued its administrative functions for the Contractor, the University of California.

The British Mission gradually dwindled after Trinity, leaving only one man at the end of 1946. Three of its members participated in Operation Crossroads.

Three major problems faced the Personnel Group: Maintenance of an adequate staff; replacement of approximately 1600 enlisted men as they were discharged; staffing B-Division for Operation Crossroads.

A new set of classifications and salaries was drafted, and approved in

February 1946, providing a greater inducement for those who had received higher salaries elsewhere. This new schedule of salaries aided in the vigorous recruiting drives to fill the vacancies left by the men in the Special Engineer Detachment and to build up the complement of B-Division. The Bikini test program was not popular with scientists generally, and it was necessary to offer a premium wage in anticipation of overseas duty.

The Personnel Office had certain personnel services including housing, maid service, laundry facilities which ultimately were given to the Zia Company, and a section of the group supervised the newspaper, automobile allocation, the radio station and the stationery stockroom. These functions, too, were transferred to the Army and the Zia Company.

The program facing the Shop Group changed from stress on production to emphasis on experimental work. Additional space was available about this time. A redistribution of activities and personnel occurred, so that every individual might be employed to better advantage in meeting schedules.

Problems facing the group varied. A reduction of hours curtailed the take-home pay of individuals. Housing remained a critical situation. The \$100.00 monthly incentive pay was discontinued about the same time the termination of return travel reimbursement was announced. Many enlisted men were discharged, further reducing personnel, and production fell behind schedule. A system was arranged whereby plastic and metal machine orders were produced in West Coast shops. This relieved the Los Alamos machine shops of an overwhelming schedule, and allowed them to work on more difficult technical problems and special fabrications. One such job was constructed on the fast reactor.

Although operations in the Procurement Office were simplified greatly at the end of 1945, requests for materials were as diversified as ever. One contributing factor, in this case, was the purchasing for the Bikini tests. Approximately 300 tons of equipment was secured for this operation.

The Property Section was combined with Procurement in April 1946. A tight property system was inaugurated the latter part of 1946.

The Technical Area Maintenance Group provided maintenance and construction services necessary for the physical operation of the Laboratory in collaboration with the Army Maintenance Groups until February 1946. At that point the Army craft shops were discontinued and the Tech Area craft shops became responsible for the entire technical area.

The safety program was originally divided into Post and Technical Area groups. However, they were centralized in January 1946 under the Post Safety Engineer, and the position of Laboratory Safety Engineer ceased to exist. The slight tendency by certain technical division safety organizations to lose interest and gradually disintegrate finally led to the appointment of a Laboratory Safety Engineer in December 1946. It was intended that he

should set up a specific safety program for the technical area and work in conjunction with the Post Safety organization.

The Photographic Group set up an expansive program during this period to increase their service facilities for the technical divisions. New equipment was added which not only increased the versatility but improved the technique of photography and duplicating systems employed.

The Health Group, which was independent of the Administrative Division, was primarily involved in termination procedures and establishing a peacetime health program at this time. Particularly was this group concerned with the two radiation accidents in August 1945 and May 1946. The symptomatic reactions of each individual involved were followed closely and case histories prepared. Activities with radiolanthanum were watched, as were the activities with plutonium and polonium. Two other responsibilities outside the routine categories included the Health Group's participation in Operation Crossroads. Training courses on basic physics and radiation problems were given by members of the Health Group to Army, Navy and Public Health doctors on Colonel Stafford Warren's staff.

The other extraneous phase of health research concerned additional information for decay curves on radiation from the Trinity test.

The Business Office was the direct representative of the Contractor and, as such, was interested in all phases of the Laboratory operations. Its functions included: the Laboratory payroll, attendance reports, travel disbursements, payments for purchases, consultant fees. In addition, it held the purse strings for the nursery school, the newspaper, the radio station, the hospital and school employees, and the technical library. It also handled all compensable accidents which occurred during this period, including the fatal accidents of Harry K. Daghljan, Louis Slotin, and Joshua I. Schwartz. Further services rendered by this office included a check cashing facility and the establishment of life insurance and group hospitalization insurance to provide benefits for persons employed at the project.

### III. Theoretical Physics Division

This division continued its wartime program on a modified and reduced scale with the added interest of intensified research on thermonuclear systems. It devoted much time to the hydrodynamical problems in the interpretation of the blast measurements at Trinity, Hiroshima, and Nagasaki; and effort was spent on the radiation hydrodynamics of the implosion fission bomb.

Further research on these programs resulted in theoretical developments for the thermonuclear system, and on the fast reactor, which was

constructed by the Physics Division and in operation by November 1946.

#### IV. Physics Division

The former Research Division and F-Division were amalgamated into a Physics Division in November 1945 with a combination of the work performed by the old divisions, plus the inclusion of the study of fast chain reactions. Of necessity there was much reorganization and rearrangement of groups and their responsibilities.

During the period under discussion, the fast reactor became a reality. The cyclotron, the Cockcroft-Walton accelerator, and the "short tank" Van de Graaff, borrowed during the war, were purchased for Los Alamos, and experimentation continued with each of these particle accelerators. Inasmuch as the Laboratory was unable to purchase the "long tank" Van de Graaff from the University of Wisconsin, a program to construct such a machine was approved early in 1946. The new Van de Graaff incorporates certain new desirable features never before attempted, making it larger and more flexible than any in existence at the time of its conception.

Other phases of research conducted by this group included experiments with the betatron and the chronotron, and studies in cosmic radiation.

#### V. M-Division

This division, formed in the fall of 1945, under Darol Froman, was assigned a program of work, including both peacetime applications of nuclear energy and a continuation of weapon development. This schedule embraced:

- (a) Maintenance of the weapon, insofar as the pit was concerned
- (b) Critical assemblies
- (c) Bomb improvements
- (d) Proposed mechanical methods of initiating thermonuclear reactions
- (e) Optical and engineering physics

Main developments during 1945-1946 were concerned with stockpiling. In connection with the field assembly program, the division established a training course for the Army Officers chosen for this operation.

Two tragic accidents occurred to members of this division. In August 1945 and May 1946, respectively, Harry Daghlion and Louis Slotin received

fatal radiation while performing experiments with critical assemblies. These occurrences halted all such activities and brought about an elaborate system of remote control. A new safety program was put into effect wherever active material assemblies which might reach critical were involved.

## VI. Chemistry and Metallurgy Research Division

Late in October 1945, the Chemistry Metallurgy Division became CMR Division under Eric R. Jette, who assumed the position of Division Leader when the co-division leaders, Joseph Kennedy and C. Smith, left the Project.

As with the case with the entire Laboratory, a reorganization of the personnel staff of the division was required by the general departure of key individuals during this interim period.

The division program comprised metallurgical and physical studies of plutonium and other transuranic elements; research and development work in polonium and plutonium chemistry; tritium research; research on the chemistry of the transuranics; radiochemistry studies, especially with radio-lanthanum; and the effects of intense radiation. CMR Division continued its extensive manufacturing function of essential nuclear elements for weapon production as well as a large service organization for production of nuclear materials for use by the other Laboratory divisions. For example, it supplied the active material in appropriate shape and condition for preparation of the Los Alamos fast reactor. A very important watchdog function included a group for monitoring and decontamination activities in the technical areas, responsibility for counters and meters for detecting radioactivity, and laundering of contaminated protective clothing.

## VII. Explosives Division

With the close of the war the Explosives Division moved toward a simplicity of structure in order to concentrate on various explosive research problems of great importance to the Laboratory program. This was possible because certain wartime programs were discontinued or transferred to other installations. G. B. Kistiakowsky departed in October 1945, leaving Max Roy as the Division Leader. The program of X Division was generally divided into six groups. These were: explosives research; explosives production; study of slow explosives; detonators; study of detonation and shock phenomena; and radiographic research.

### VIII. Ordnance Engineering (Z) Division

This division was established in the Laboratory just prior to the termination of hostilities. It remained in a state of flux until late 1945, when a more formalized organization was established. However, the division was split between Sandia Base at Albuquerque and the Los Alamos Laboratory, with testing sites as far apart as Wendover Field, Utah, and Salton Sea, California. This separation of effort, along with severe housing problems, greatly hampered the operation of the division. The program of Z Division embraced five parts: testing of the components of the weapons under actual conditions to which they would be submitted; design of new components and redesign of existing components of the ordnance phases of the weapon; development of improved replacement items involved in the implosion weapon for use in the stock pile; stock piling of all component parts of the weapon other than the nuclear components; and assembly of the weapons.

### IX. Documentary Division

In order to relieve the Director of the supervision of a large staff of special technical groups, a new Documentary Division was established in the fall of 1946, combining the groups having the responsibility for Library and Document Room, the Technical Series and History, report editing, declassification, classified information dissemination, legal and patent matters, and technical illustration and art work. Ralph Carlisle Smith was appointed Chief to this division with Herbert I. Miller as his alternate. The new organization greatly improved the services of these individual groups, at the same time effecting a substantial reduction of personnel.

### X. Conclusion

The Los Alamos Laboratory operated throughout 1946 on the interim philosophy expressed by Dr. Bradbury in October 1945. Progress had been made in all the technical fields bearing on weapon development. However, the Laboratory was still without a clear-cut policy for its future. The Manhattan Engineer District had completed its mission. The Atomic Energy Commission would direct the course of the Laboratory after 1 January 1947.



Dr. Bradbury, in anticipation of various questions which might arise in deciding the long range policy for Los Alamos, prepared a letter outlining the past history, problems of the Laboratory, and suggestions for a possible future Laboratory program. This letter was presented to the Commission on its first visit to Los Alamos in November 1946.

## Chapter I

### GENERAL AND TECHNICAL REVIEW

#### Necessity for Post War Policy

##### GENERAL

1.1 With the close of the war and in the absence of national legislation on the subject of atomic energy, the Los Alamos Laboratory and the Manhattan Engineer District were faced with the problem of determining an appropriate policy for a laboratory whose previous existence had been devoted to the problem of the atomic weapon.

##### PERSONNEL PROBLEMS

1.2 The Laboratory had been staffed with almost ruthless abandon with personnel taken from universities, from NDRC and OSRD laboratories, from industry, with graduate students, technicians, and scientists of every degree of eminence. Not only did the background and commitments of every individual vary, but their opinions as to the character and future of the Laboratory differed in almost every conceivable way. Intimately mixed with the civilian personnel of the Laboratory were enlisted and officer personnel, many of whom with the cessation of hostilities had a profound change of attitude towards the technical work. In September 1945, the Laboratory staff could be roughly divided into the following groups:

##### A. Academic Personnel on Leave from Colleges and Universities

1.3 Due to the rather sudden termination of hostilities and its occurrence right at the start of the academic year, most of these individuals were

not free to return directly to their universities and take up the normal course of academic work. Moreover, the extraordinary reputation gained by science in the course of the war, and the specific achievements of physicists in particular, led many universities to attempt to build up their technical staffs which had been seriously depleted by the war. As a consequence, many individuals were approached with a variety of job offers from not only other universities and colleges but from industrial organizations. The salary increases offered provided a not inconsiderable temptation to "shop around" and this naturally occurred to a considerable extent.

#### B. Young Ph.D.'s Very Recently from Graduate School

1.4 Such individuals had experienced practically all of their scientific life in government laboratories from 1940 on. As a consequence they had become, in many cases unknowingly, accustomed to the speed, intensity, and particularly the technical and administrative services provided in wartime laboratories. In many cases, these individuals were by no means certain as to the type of career they wished to follow. Academic careers, industry, and government or atomic energy laboratories competed on reasonably equal ground. Again, the enhanced prestige of scientists led to a desire to see where the most attractive offer might arise.

#### C. Graduate Students of Varying Degrees of Experience

1.5 Most of these individuals had gone into war work as civilians fairly early in the war, interrupting their graduate careers at one, two or three years beyond the bachelor's degree. These individuals were faced with another type of problem: They had frequently acquired families as well as corresponding financial responsibilities. They had usually become rather specialized in specific fields and lacked the broader knowledge which their maturity might have implied. During the course of the war, they had lost touch with academic procedures and channels of thought, and foresaw that return to graduate work might be difficult. To all of them occurred the problem of whether or not to resume their graduate studies and the recognition that their failure to do so might in some way handicap them later on.

#### D. Technicians, Administrative, and Clerical Personnel

1.6 The more senior of these individuals were not infrequently on leave from other places of employment. Although possibly less tied by previous commitments than scientific personnel, they nevertheless were concerned with the problem of deciding what to do with their personal careers. To some extent their problem was complicated by the fact that the more junior of these people were not infrequently housed in the less satisfactory accommodations, and were therefore anxious to return to a more normal

environment with the removal of patriotic pressure.

#### E. Officers and Enlisted Personnel of the Army and Navy

1.7 Individuals in uniform were to be found in all the general classifications above, as well as on leave from industrial organizations. The higher ranking officers were usually senior personnel who had taken leave from universities or industry to accept commissions early in the war. Many enlisted personnel were products of the special training programs of the armed forces. Some of the enlisted personnel had been drafted and some had enlisted. All were tied in one degree or another to previous commitments, or to return to school, and by the almost universal bond of a desire to get out of uniform. Life in barracks for enlisted personnel, many of whom had had extensive technical training, had proved a serious trial. To the large majority of the enlisted personnel who had performed so successfully and diligently during the war, the peace brought complete apathy and indifference to the problems and activities of the Laboratory. Their one desire was to be discharged and return home to a "normal" life.

#### MISCELLANEOUS PROBLEMS

1.8 It is clear from the above that the individuals who comprised the Laboratory staff at the close of the war made up a group of people who were far from certain that they wished to remain at Los Alamos, and in many cases who were committed by decision or desire to departure. Not only was the technical future of the Laboratory uncertain, but its administration was equally unclear. The combination of an absentee contractor and Army administration of the community and auxiliary services had aroused a state of antagonism and irritation, that, for many people, could be solved only by leaving Los Alamos. These problems were combined with that of the generally indifferent enlisted personnel on whom the Laboratory had come to depend. Another difficulty was presented by the civilian personnel who remained on the payroll of the Laboratory, but who were also indifferent as to its future and awaited only the best opportunity, from personal motives, to leave. When all of these problems were added to the basic concern as to a proper philosophy for the Laboratory, it presented an extremely complicated personnel picture.

## Proposed Philosophies

1.9 Added to the many types of individuals representing the Laboratory staff were almost as many opinions as to what the Laboratory should do as a peacetime activity. While a general classification of these philosophies is difficult in view of the many gradations of opinion and partial acceptance of portions of several points of view, it is possible to present the major differences of opinion.

1.10 One group, headed by one of the most senior members of the Laboratory, contended that the Laboratory should become a monument - that it should be abandoned and its functions, if necessary or useful to peacetime activity, taken up elsewhere.

1.11 Another philosophy suggested that the Laboratory should abandon its production activities in connection with atomic weapons and should conduct only peaceful research, or basic research whose application might be in the indefinite future.

1.12 Still another philosophy held that the basic purpose of the Laboratory was atomic weapon research and development, and that for the present at least, the design and production of atomic weapons might or must continue.

1.13 Naturally, all variations and combinations of these philosophies existed, and were further complicated by the unresolved question as to whether or not a location on an isolated mesa top in New Mexico, chosen for a variety of wartime reasons, was adequate or satisfactory as a peacetime location for a laboratory of any character.

## Transition Period

1.14 In the months immediately following the close of the war, it is probably fair to say that technical activity came practically to a standstill. The intense technical effort which culminated in the delivery of atomic weapons at Hiroshima and Nagasaki, when followed by the climax of victory, not unnaturally resulted in a complete psychological deflation.

1.15 In October 1945, Dr. J. R. Oppenheimer announced his intention to relinquish his direction of the Laboratory. On October 17, Dr. N. E. Bradbury, at the request of Dr. Oppenheimer and Major General L. R. Groves, assumed the position of Director of the Laboratory for an agreed six months period, or until such time as national legislation was prepared

and passed, should this occur sooner.

1.16 In a talk delivered on October 1, 1945 to the Coordinating Council of the Laboratory, Dr. Bradbury described his conception of a philosophy for the Laboratory during the so-called "interim" period of its operation. This period was assumed to be that between the close of the war and the effective establishment of national legislation on the subject of atomic energy. A resumé of this discussion is given in Appendix 1. In brief, the operational philosophy was based upon the assumption that Los Alamos would remain as an operating laboratory; that its location would remain at the present site; that its problems and goals would be those pertinent to research and development of atomic weapons or matters related thereto; that such weapon problems would be considered both on a short and on a long range basis; and that the staff of the Laboratory would decrease to approximately one-third of its wartime level due to the scarcity of housing and the departure of military personnel previously housed in barracks who would have to be replaced by civilians with families requiring houses.

1.17 The general plans for the future, already started, which agreed in part with the philosophy of the Laboratory as expressed by Dr. Bradbury (Appendix 1) were explained by General L. R. Groves in a letter dated January 4, 1946 (Appendix 2). The paramount problem of the Laboratory, then, was to establish its internal technical and administrative structure and to determine the composition of its technical staff.

1.18 The state of indecision of many personnel of the Laboratory, during the spring of 1946, was having a serious effect on the morale of the Laboratory. It became increasingly evident that the Laboratory required for intelligent planning and for a vigorous program a staff whose size and character could be estimated definitely, and a staff committed to and enthusiastic about the future of the Laboratory. After considerable debate, it was decided to abandon, except for certain special cases, the previous policy of paying the way home of Laboratory personnel at any time the individual decided to terminate. This policy was announced in May 1946, to go into effect on September 1, 1946. The effect was exactly as expected - individuals, undecided prior to that time, made a decision to go or to stay. Those who stayed were, by that act, committed to working for the success of Los Alamos.

### Peacetime Activities Introduced

#### THE LOS ALAMOS UNIVERSITY

1.19 The early tendency to think of the Laboratory's task as finished

led in September 1945 to the establishment of the Los Alamos University, a facetious title for a program of technical lectures given as semitradeional academic courses to junior Laboratory personnel. The intent behind this proposal was to facilitate as far as possible the return of enlisted personnel and junior civilian personnel to complete their academic training. Since these courses were conducted during normal working hours, they conflicted with the day-to-day operation of the project, and served largely to confuse further the problem of individuals trying to build up the Laboratory. The schedule of courses and the lectures is given in Appendix 3. Approximately 678 men availed themselves of this opportunity, and 134 were given college credit for their work. (Appendix 4 shows complete statistics on enrollment and earned credit in each course).

#### PROGRAM FOR CONSULTANTS

1.20 Although a number of the senior personnel leaving Los Alamos during the twelve month period following the war left with strong convictions concerning their future association with classified work and with atomic weapon research in particular, a larger number recognized the general need for this type of work to continue, and felt to varying degrees some wish or willingness to participate. The Laboratory also recognized the desirability of being able to call upon, where possible, previous members of the Laboratory for consultation in connection with Laboratory problems. Accordingly, an extensive program of Laboratory consultants was set up which was implemented by periodic visits of personnel to the Laboratory to work with its present staff on problems, many of which had their roots in the wartime existence of the Laboratory.

#### APRIL CONFERENCE

1.21 Various conferences on highly classified matters were scheduled during 1946, one of the more important being the conference on the "Super" held April 17 to April 23 and led by Dr. Edward Teller (3.20).

#### UNIVERSITY AFFILIATION CONFERENCE

1.22 During the course of operation of the Laboratory, it became apparent that not only could the techniques of the Laboratory (where declassifiable) add to the advance of science in the country, but that the Laboratory

could profitably use some form of cordial relations with universities. While it was recognized that the Laboratory could not become a regional laboratory of the type being proposed for Brookhaven and Argonne and suggested for Clinton, nevertheless, there appeared to be certain aspects of this procedure which could be applied with profit to Los Alamos. Accordingly, in July 1946 representatives from universities west of the Mississippi river were invited to a conference to explore the possibilities of cooperation between the universities of that region and Los Alamos. The conference centered on the possibilities which Los Alamos offered for the training of graduate students in physics and chemistry, and particularly in the facilities which the Laboratory offered for thesis work leading toward the doctor's degree. While the Laboratory could only offer responsibility for the direction of the thesis work of graduate students in fields of interest to the Laboratory, such thesis under appropriate conditions could be evaluated by the university granting the degree and conducting the examinations. The report of this conference is Appendix 5.

#### AUGUST CONFERENCE

1.23 This consultant and conference program had a type of climax in the summer of 1946 with a large conference held between August 19, 1946, and August 24, 1946, attended both by the staff of the Laboratory, members of the staffs of other Manhattan District laboratories, and by consultants to Los Alamos. The total attendance from outside the Laboratory reached 57, and the technical program as well as the informal conferences on Laboratory activities covered six days. The formal program of the conference is attached as Appendix 6.

#### Health and Safety Program

1.24 Of primary concern to the scientific personnel of the Laboratory was the nature of the medical care provided for the staff and the residents of the community. During the war, most of the medical personnel at Los Alamos were in uniform; as their discharge became imminent, it became necessary to employ civilian doctors. At the same time, it became evident that as a peacetime activity, the Laboratory could not in any sense afford to take any chances with human life. It was therefore necessary to place an increasing emphasis on the medical research and industrial health research program of the Laboratory, as well as its general safety practices.



The Director of the Laboratory issued a directive to the effect that any practice, known to be unsafe, was to be stopped, irrespective of its priority and importance to the Laboratory program. In the spring of 1946 the possibility of establishing a link with a well-known medical school was explored in order to provide a board from whom advice on medical matters might be obtained. This culminated in an agreement with Washington University at St. Louis, Missouri, where such a board was established.

### RADIATION FATALITIES

1.25 In spite of the increased emphasis on safety, two serious accidents occurred in the course of technical work. Both of these occurred during experiments involving critical assemblies, the first on August 21, 1945, resulting in the death of Harry K. Daghlian on September 15, 1945, and the second on May 21, 1946, resulting in the death of Dr. Louis Slotin on May 30, 1946. The second accident emphasized the fact that such accidents could occur with the most senior personnel in charge and led to the establishment of a system of remote control for the necessary experimentation in this field (5.11 ff).

### Water Shortage

1.26 No other serious Laboratory disasters occurred during this period although the water shortage during the winter of 1945-46 for its severity and duration requires special mention. This event was the climax in the bitter resentment to the system of Los Alamos Community operation, and doubtless hastened or inspired the exodus of many personnel already unhappy with existence at Los Alamos.

### Technical Organization

1.27 Prior to the close of the war, the Laboratory, in addition to certain technical and administrative staff groups, was composed of technical divisions as indicated in the table on following page:

		<u>Date Left Project</u>
Chemistry and Metallurgy (CM)	Joseph Kennedy	20 December 1945
	Cyril S. Smith	2 January 1946
Physics (R)	Robert R. Wilson	8 February 1946
Physics (F)	Enrico Fermi	31 December 1945
Theoretical (T)	Hans Bethe	2 January 1946
Explosives (X)	George Kistiakowsky	17 January 1946
Gadgets (G)	Robert Bacher	15 January 1946
Engineering (Ordnance) (Z)	J. R. Zacharias	1 November 1945

1.28 These individuals left the Laboratory on the dates indicated, but in most cases the administration of the Technical Division had been transferred and reorganized as indicated below:

Chemistry and Metallurgy (CMR)	Eric Jette
Physics (P)(Division combined)	John Manley
Theoretical (T)	George Placzek
Explosives (X)	Max Roy
Experimental (old Gadget) (M)	Darol Froman
Engineering (Ordnance) (Z)	Roger Warner
Documentary (D) (August 1946)	Ralph Carlisle Smith

1.29 In July 1946, J. M. B. Kellogg assumed direction of the Physics Division in order to leave Manley free, at his request, to engage in experimental work; and in November 1946, R. D. Richtmyer took over the Theoretical Division.

1.30 In practically every case the Laboratory was fortunate in obtaining the services as Division Leader of individuals who had had extensive prior experience in the Laboratory and who, in many cases, had been in position of high responsibility in the divisions which they were now directing.

1.31 As has been shown (1.28), the Laboratory was organized eventually into seven technical divisions, and certain technical staff groups and an Administrative Division. These divisions in turn were divided into groups having particular but closely interrelated responsibilities. The detailed technical history of the Laboratory is set forth in the monthly progress reports of each division. The interaction of these reports with each other and the corresponding general technical advance of the Laboratory over a broad field may be less clear, and will be discussed in more detail in the following chapters. At the same time, the specific identification of these groups and the general nature of their individual responsibilities will be described at greater length.

## TECHNICAL ADVISORY BOARDS

1.32 In November 1946, there were organized two technical committees to assist the Director in formulating the technical program of the Laboratory. These were known as the Technical Board and the Weapons Panel. The former was comprised of all division leaders, and the latter of the division leaders of Ordnance Engineering Z, Chemistry and Metallurgy CMR, Explosives X, and M Divisions. The functions of these two groups rapidly became indistinguishable and their separate meetings gradually merged into one. The coordinating council, comprising group and division leaders and certain senior scientific personnel, was continued as the interim council. However, the colloquium composed of all staff members was discontinued.

## Continuance of the Weapon Engineering Program

1.33 While the technical program of the Los Alamos Laboratory took some time to evolve, it was clear from the end of the war that there remained a considerable program of pure ordnance engineering of the weapon. Necessarily, this phase of the development of the bomb had been neglected or hurried in order to bring the weapon into the conflict at the earliest possible date. The need for over-all design improvement was, however, apparent to all. During the course of the war, all of the engineering had been conducted at Los Alamos with the major portion of the field test activity carried out at Wendover Field, Utah. The selection of this site, while advantageous from a security point of view, gave rise to practically insurmountable difficulties in peace time due to its great distance and relative inaccessibility from Los Alamos. In the fall of 1945, arrangements were completed to transfer this activity to Oxnard Field, now known as Sandia Base, near Albuquerque, New Mexico. A modest number of buildings were already available together with facilities for troops. The nearby Kirtland Field was employed to base the B-29 squadron needed for the test program. A portion of the explosive materials stored at Wendover were transferred to the Fort Wingate Depot near Gallup, New Mexico. This will be discussed at greater length in connection with Z-Division (Chapter VIII).

1.34 During this same time, the Salton Sea Navy base which had been of some use during the spring and summer of 1945 was utilized as the major test location of the Ordnance Engineering (Z) Division, and the major portion of its drop test program conducted there.

1.35 As will be seen in the discussion of Explosives (X) Division

(Chapter VII), facilities for full scale high explosive production were closed down at Los Alamos owing to lack of personnel and the deterioration of the temporary buildings in which these lines were housed. The Inyokern (California) project, which had been initiated during the war for the production of experimental half-scale castings, was now over-designed for this purpose. Accordingly, arrangements were made with the Navy Bureau of Ordnance to carry out full scale casting operations at this location, and the plant was revised accordingly. Delivery of reasonably satisfactory full scale castings was begun in the winter of 1946.

### Operation Crossroads

1.36 In December 1945, the Laboratory was informed that a test of atomic weapons against naval vessels was proposed, and the Laboratory was requested to undertake the technical direction of this test as well as to supply the atomic weapons to be used therein. Preliminary meetings were held in December 1945 and January 1946, during the course of which it was decided to:

- (a) Set up a Joint Task Force Operation with the Army, Navy, and Manhattan Engineer District.
- (b) To employ the same type of atomic weapon as used at Nagasaki.
- (c) To recommend three types of test to be conducted in the order given below:

Able: Air burst over an array of representative ships.

Baker: Shallow water burst under an array of representative ships.

Charlie: Deep water burst under an array of representative ships.

1.37 The atoll of Bikini in the Marshall Islands was selected by the Navy as a satisfactory location for tests "Able" and "Baker," with possibility that test "Charlie" might be conducted on the deep water side of the atoll.

1.38 The Laboratory selected Dr. Ralph A. Sawyer as Technical Director for this operation, with Dr. Marshall Holloway (B-Division) and Mr. Roger Warner (Z-Division) under him as heads of the Los Alamos experimental groups and weapon preparation groups, respectively.

1.39 The question of what weapon to employ in these tests was the subject of much discussion. The recommendation of the Laboratory was to employ the Nagasaki type weapon, in spite of the fact that a different type of weapon existed and was urgently in need of test. The basis for the

Laboratory's recommendation came from the following arguments:

- (a) The purpose of the test was purely and frankly military. It was not even certain that an accurate measurement of nuclear efficiency and equivalent high explosive yield would or could be obtained. Therefore it was important from the point of military strategy and tactics to employ a weapon which had previously been used in combat over a city in order that the use of the same weapon under different types of circumstances might be compared.
- (b) Had a new and untried weapon been employed, and had poor efficiency been obtained, the Laboratory and the Joint Task Force would have been seriously criticized for not using a "proven" weapon.
- (c) In view of the nature of the tests in which the effect of an atomic weapon was primarily to be studied rather than the weapon itself, the Laboratory was unwilling to employ a new weapon under these circumstances when the actual character of the weapon's behavior might be difficult or impossible to ascertain.

1.40 The responsibilities which the Laboratory agreed to accept for this operation, in addition to supplying the technical direction, were as follows:

- (a) Prepare recommendations for the over-all character of the test including disposition of ships, height (or depth of burst), and nature of weapons to be employed.
- (b) Prepare a "handbook" of phenomena to be expected from the operation in order that other participants might have a technical guess as to what to expect and thereby make more reasonable technical preparations.
- (c) Be responsible for at least one definite estimate of the equivalent high explosive yield of the weapon. It was decided to attempt this by radiochemical methods, by photographic methods (for the air burst), and by fast neutron measurements (for the air burst). The technique of estimating yield from blast measurements was assigned to the Navy Bureau of Ordnance. It will be noticed that the underwater burst presented the greatest problem of measurement from the point of view of possible failure of the radiochemical technique. This problem was particularly serious in view of the fact that a weapon had never before been detonated with water as the surrounding medium. While no serious doubt existed on this matter, it was nevertheless not completely certain that an atomic weapon would transfer energy to a more dense medium in exactly the same manner as it would transfer energy to air. Accordingly, one timing

measurement was conducted to measure the time from first current to the detonators to the first appearance of ionization due to the gamma rays emitted by the bomb. A proper value of this time would indicate "normal" performance, whereas too small or too great a value would suggest a "subnormal" performance. Fortunately the radiochemical technique was successful, and the time measurement merely supported the radiochemical observations.

- (d) Prepare the firing circuits for the underwater test, as well as the timing system with radio links, both transmitting and receiving, to be associated with both tests.
- (e) Prepare the weapons for both tests, including the preparation of an appropriately engineered barge from which to suspend the weapon for the subsurface test. Included in this responsibility was the supervision of the training of practice flights prior to the actual drop.

1.41 The original target date set for the tests, namely May 15, 1946, was such as to require that no equipment to be involved in the test could be developed or engineered to appropriate specifications. It was necessary to employ equipment already on hand or that which could be easily modified to do the job required of it. This posed a particular problem for the radio links involved in the transmission and reception of radio timing signals at definite time intervals prior to the detonation of the weapons. The haste with which these had to be procured and modified from stock items, intended for another purpose, was such as to introduce a marginal character into this piece of equipment from which the most tedious difficulties developed during the course of the summer. Although the tests were subsequently delayed by Presidential announcement on March 22, 1946, this additional time, of course, did not suffice to permit any change in equipment then ordered and in process. The delay of the test may actually have done more harm than good to certain phases of the operation where the psychological "letdown" was severe. However, it is probable that the additional time was most profitable for some of the engineering and logistic phases of the operation.

1.42 Two ships, the Cumberland Sound and the Albermarle, were assigned to Los Alamos personnel for their operations. The former was the headquarters of Dr. Holloway and was appropriately modified as a laboratory ship; whereas the latter was the headquarters of Mr. Warner and the bomb assembly groups and was suitably reworked for the assembly operations. A weekly C-54 run was established between Santa Fe and Washington, D. C., to permit the necessary close liaison between the Laboratory and other technical personnel in Washington.

1.43 Detailed reports of the technical operation have been issued. Other reports exist from the other agencies participating but the nature of all of these is not known to the Laboratory.

1.44 The cost to the Laboratory measured in cost of additional procurement is roughly one million dollars. It took the time of about 150 Laboratory personnel (approximately one-eighth of the Laboratory staff) for almost nine months. While technical divisions located at Los Alamos were adversely affected by the Crossroads operation, the effect on the Ordnance Engineering (Z) Division split between Los Alamos and Albuquerque was enormous and resulted in almost total stoppage of their development and engineering programs as the result of the necessary preoccupation of their senior personnel with the Bikini effort.

1.45 Although Crossroads involved a high cost to the Laboratory, this operation was not without its gains. It occurred at a time when the Laboratory was seriously engaged in post-war reconstruction, and may have given to the Laboratory an objective or goal, which while not entirely welcome, was not without its psychological advantage. Furthermore, the ability of the Laboratory to produce satisfactory weapons after the departure of much of its senior and experienced staff was undoubtedly a demonstration which had favorable effects both within and without the Laboratory. Similar to this effect was the ability of the Laboratory to participate strongly in an operation rather definitely in the public eye.

1.46 The operation was not lacking in technical gain as well. Aside from the fact that it provided Laboratory staff with additional experience in the practical conduct of atomic weapon tests that could only be useful in the planning stages of necessary subsequent operations, it supplied certain technical data the ultimate significance of which should not be underestimated. The fact that the Bikini weapons had almost identical efficiency with those of the same type detonated previously was something of a surprise and may not yet be full understood. The rise of the vapor column in the air shot suggested further problems to be worked on, besides demonstrating the absence of fall-out where dust is not present. The underwater shot proved the basic assumption that an atomic weapon behaves satisfactorily with water surrounding it, as well as gave an excellent large-scale demonstration of the water column effects to be observed, showing new phenomena. The existence of a more penetrating radiation than can easily be accounted for was observed, substantiating certain physiological observations in connection with the Nagasaki detonation.

## Chapter II

### ADMINISTRATIVE ORGANIZATION

#### Introduction

2.1 As has been pointed out before (Vol. I, 3.20), the reviewing committee had spoken of the need for an Associate Director and an Administrative Assistant to relieve the Director of some of the multitude of problems that were brought to him personally. This was accomplished in a measure by the appointment of David Dow to the position of Assistant to the Director, but a further strengthening of the entire administrative organization was indicated.

#### Administrative Structure

#### ASSOCIATE DIRECTOR APPOINTED

2.2 In the fall of 1945, Dr. Oppenheimer decided to utilize Col. L. E. Seeman (General Groves' liaison officer at Project Y) as his administrator and arranged for Col. Seeman's permanent assignment to Los Alamos. On October 31, 1945, Col. Seeman was appointed Associate Director to N. E. Bradbury (who had accepted the position of Director after the resignation of Dr. Oppenheimer in October 1945). He was further designated as officer-in-charge of the Santa Fe Area, Manhattan District. This dual responsibility embraced not only the military divisions including Security, Post Command, Area Engineer and the hospital, but also the administrative and certain technical functions of the Laboratory.



## ADMINISTRATION AND SERVICES DIVISION FORMED

2.3 To bring about a closely knit administration and service organization, a new division was set up in December 1945 with Col. Seeman as Division Leader and Col. A. W. Betts as his Deputy, comprised of the following groups:

A-1	Administrative Group	David Dow
A-2	Personnel Group	E. J. Demson
A-3	Shop Group	Gus Schultz
A-4	Procurement Group	Harry S. Allen
A-5	Tech Area Maintenance	Lt. Robert C. Hill (USNR)
A-6	Safety Group	Eldon E. Beck

About April 1946, Mr. E. J. Demson was made Assistant Director and John V. Young was made Personnel Group Leader.

2.4 The arrangement seemed to function very well as evidenced from a letter by N. E. Bradbury to Robert M. Underhill on January 28, 1946, which is quoted in part: "We have found that to have Colonel Seeman acting as Associate Director as well as Area Engineer has been of the greatest assistance in smoothing and expediting the relationships between the Technical Area, The Post Military organization, Lt. Col. Stewart's office, and the District Engineer. I quite concur that this arrangement can serve as an additional protection to the University".

## TECHNICAL STAFF GROUPS

2.5 The following technical staff groups remained unaffected by this change and were directly responsible to the Director:

A-7	Editorial Group	David R. Inglis
A-8	History Group	David Hawkins
A-9	Patent Group	Major Ralph Carlisle Smith
A-10	Health Group	Dr. Louis Hempelmann
A-14	Library Group	Inez O'Brien
A-15	Declassification Group	Frederic de Hoffmann

The Technical Staff groups reporting directly to the Director were considerably reduced by the formation of D Division under Major Ralph Carlisle Smith in August 1946. This new division absorbed A-7 Editorial Group, A-8 History Group, A-9 Patent Group, A-14 Library and Document Room, A-15 Declassification Group, the Technical Series Group previously under Dr. Hans Bethe

of the Theoretical Division, and the duties of the Assistant Director, Mr. Demson.(9.1). A-10 Health Group, under direction of Dr. Louis Hempelmann, remained as the only independent staff group. It will be discussed later (2.70 ff).

### BUSINESS OFFICE

2.6 The Business Office, A-11, of course, continued its administrative function for the University of California under the supervision of J. A. D. Muncy, Business Manager, until June 1, 1946, when A. E. Dyhre assumed that position (2.86 ff).

### BRITISH MISSION

2.7 The British Mission personnel started departing from the Laboratory shortly after the Trinity test at Alamogordo Air Base on July 16, 1945, leaving only Ernest Titterton as their representative in the Laboratory at the close of 1946. During the spring and summer of 1946, W. G. Penney, J. L. Tuck, and E. W. Titterton served with B Division in Operation Cross-roads.

### Organization of A and S Division December 1946

2.8 As time progressed, certain changes in the organization of the A and S Division were made to keep it streamlined and functioning as efficiently as possible. These changes will be discussed at greater length throughout this chapter under the various groups. The organizational set-up at the end of 1946 was as follows:

Associate Director for Administration  
and Services

Col. Austin W. Betts

Assistant Associate Director for  
Administration and Services

Henry Hoyt

A-2 Personnel Group

John V. Young

A-13 Central Mail & Records

George S. Challis

A-3 Shop Group

Gus Schultz

A-4 Supply and Property Group

Harry S. Allen

A-5 Tech Area Maintenance

Robert C. Hill

A-6 Safety

Conrad W. Thomas

A-1 Photographic Group

Loris Gardner

## PERSONNEL GROUP

2.9 By way of reviewing the personnel situation, an attempt had been made under C. D. Shane's direction, beginning in the summer of 1944, to organize the Personnel Office in such a way that it might carry out its responsibilities in the administration of a large laboratory. Specific functions were assigned various members of the office, and the record-keeping system was revised and completed.

2.10 The demands of the growing Laboratory for new employees continued to be the major concern of the Personnel Office, and the recruiting function absorbed most of the attention of the small staff. Enlargement of the staff to carry on more adequately the other functions could not be considered because of the housing shortage. Administrative needs for personnel were properly subordinated to the needs of the technical staff.

2.11 The personnel policy for the Laboratory, finally approved in February 1944, plus Shane's understanding with the Area Engineer and Contracting Officer, Lt. Col. S. L. Stewart, that local decisions on salary matters would be reviewed only in terms of stabilization rules, broke the deadlock on salary administration which had plagued the Laboratory for more than a year. From the middle of 1944 until the end of the war, routine cases of reclassification and salary adjustment were processed with minimum delay and disagreement, but special cases not in strict conformance to the rules as interpreted by the Area Engineer continued to be troublesome. For example, proposed increases of salaries above the "OSRD scale" were usually disapproved even though government stabilization regulations were not violated. The OSRD scale was a rule-of-thumb based on education and experience which the Laboratory regarded as appropriate for a norm or average, but which was considered a maximum by the Area Engineer office.

2.12 With the end of hostilities in August 1945, the tremendous pressure on the Laboratory to produce results quickly was eased, and it was possible to consider the organization of a permanent peace-time operation.

2.13 Three major personnel problems faced the Laboratory at that time. In order of importance, they were:

- (a) Maintenance of an adequate scientific staff, now that the urgency was at an end and many staff members were returning to their pre-war posts or were considering attractive offers from other laboratories.
- (b) Replacement of the approximately 1600 young scientists comprising the Special Engineer Detachment who would shortly be discharged.
- (c) Staffing a special division for technical operations of the Bikini tests scheduled for the summer of 1946.

2.14 The problem of holding a scientific staff together was exaggerated by uncertainties as to the program of the Laboratory and by the rigid system of salary control left over from war-time operation. Most scientists who considered remaining were willing to gamble on the program, since it was beyond the authority of those in charge to establish a long term plan at once. They could not be so sympathetic with the perpetuation of the salary stabilization program, since they had ample evidence in the form of eager offers from other installations that wartime controls were not inhibiting our competitors for their services. This crisis was met by an emergency operation which involved waiving the stabilization rules in case after case on an individual basis. Meantime, a more realistic set of classifications was hastily drafted and finally approved February 1, 1946. The new classifications and salaries provided a necessary inducement, although in many cases scientists persuaded themselves to stay here in the face of even higher salary offers elsewhere. Intangibles such as anticipation of interesting and productive work, a belief in the necessity of the work in the national interest, loyalty to the Laboratory where often their careers had started, the fascination of the surrounding country--all played an important role in keeping a competent group of scientists at Los Alamos.

2.15 The loss of personnel which faced the Laboratory because of anticipated discharges in the SED was met by two programs of recruitment. Those men who had proved themselves competent while serving in uniform were offered civilian jobs and a formal request for military discharge, for the convenience of the government, if discharge was not imminent, on the condition that they would agree to stay for at least six months. A considerable number of these offers were accepted, and in many cases the offer from the Laboratory was useful in obtaining an accelerated discharge under War Department regulations. A vigorous program of outside recruiting was also organized, and schools throughout the country were visited to interest promising students in employment here.

2.16 The Bikini test program was not popular with scientists generally, since few of them were interested in the ordnance aspects, and many could not see that scientific knowledge would be advanced proportionately to the effort expended. It was found necessary, both to interest Los Alamos scientists and to facilitate outside recruitment for Bikini, to offer a premium wage in anticipation of probable overseas duty to the scientists participating. A country-wide recruiting program was successful in locating quickly sufficient additional personnel for this Laboratory's part in the Bikini operations, but certain problems inevitably arose. For example, a minor crisis occurred in the already acute housing situation, since the services of the new employees were required immediately. The emergency transfer of

prefabricated units by truck from Hanford was one attempt to ease the shortage, but it was also necessary to resort to other expedients, such as converting barracks into makeshift apartments.

2.17 In the fall of 1945, C. D. Shane and R. E. Clausen returned to their university posts, and the Personnel Office was reorganized under E. J. Demson. The staff was expanded and sections were set up with more specific responsibilities, such as job evaluation, employment, and wage administration, and the Files and Records Section was enlarged to make certain personnel information more readily available.

2.18 With the end of wartime salary and wage stabilization, there began a nation-wide upward trend of salaries and wages. The Laboratory experienced difficulty in keeping up with such movements because any increase allowed was subject to such prolonged scrutiny that by the time the increase became effective it had also become insufficient.

2.19 It had been apparent for some time that a new system of salary adjustment was required for long-term operation of the Laboratory. As the first step in developing a new system, a job evaluation program was proposed shortly after the end of the war. In the expansion of the Personnel Group, Demson requested the employment of John V. Young as a general assistant, and when Demson was appointed Assistant Director early in April 1946, Young was named Personnel Director. Until the end of 1946, the efforts and attention of the personnel staff were devoted to handling the personnel transition from war to peace-time operation; hence permanent policies and operating procedures received little attention, although their importance was recognized.

2.20 As has been said previously (Vol. I), the Laboratory had maintained on the payroll certain personnel employed in the school, the nursery school, the hospital, and housing office, only because these functions were necessary, and there was no other available agency to employ the necessary personnel. However, the Laboratory maintained no supervisory control over these agencies.

2.21 The Housing Office staffed the functions of maid service, express service, housing maintenance (in cooperation with Post Operations), a project public laundry facility, as well as allocation of all project housing, until February 1946, when the Army took over these functions. Later Zia Company accepted this responsibility as well as the employment of personnel for the hospital and schools.

2.22 In January 1946, the Personnel Services section of the Personnel Group, under George Challis, undertook an allocation plan for providing new

cars at Los Alamos. In a letter of January 28, 1946, Dr. Bradbury proposed that cars be allocated to this community for priority distribution to residents. Four automobile manufacturers (Buick, Cadillac, Chevrolet, and Ford) consented to participate and the first units were received in May 1946.

2.23 The Los Alamos Times, a project newspaper, was established under the supervision of the Personnel Services Section, and the first issue was printed March 15, 1946. Since that date, this weekly publication has carried news of interest and information for residents of the Hill (2.105).

#### PERSONNEL SERVICES GROUP

2.24 A new Administrative and Service Group (A-13, Personnel Services) was formed in May 1946 to administer certain Laboratory and community functions formerly handled in the Personnel Group. Facilities charged to this group were Technical Area Mail Room and Messenger Service, Stationery Stockroom, the car allocation plan, the Community Radio Station and the newspaper, until the three latter functions were transferred to the Zia Company and the Army. Later the Stationery Stockroom was returned to the Procurement Group, A-4.

2.25 The radio station, KRS, was originally a true community operation with volunteer service, but with the advent of the Personnel Services organization financial assistance for the station was obtained under the operating contract, and it was put on a regular, full-time operating schedule with hired staff members. The contractor did not exercise supervisory authority, however.

2.26 On November 1, 1946, the jurisdiction of the newspaper, radio station, and car allocations plan was transferred to the Army, with personnel employed by the Zia Company, and the organization known as Personnel Services ceased to exist.

2.27 Instead, Group A-13 became the Central Mail and Records Group and began concentrating on the establishment of a Central Mail Records function for the Laboratory and improvement of mail and messenger services. Under the newly organized system, all incoming Laboratory mail was distributed to offices, mail records procedures were established, and the files of the Director and Associate Director offices were consolidated with the material being recataloged.

## SHOPS

2.28 Following Japan's surrender, the Machine Shops Group went through the inevitable transition which was experienced by the rest of the Laboratory. There was a profound change in the shop work program. Stress on production decreased and was replaced by a strong emphasis on experimental work. Personnel was reduced approximately 33 per cent in accordance with a directive from Dr. N. E. Bradbury. The night shift was discontinued October 1, 1945, and a controlled redistribution of personnel was made, thereby employing the individuals to better advantage in meeting the schedule demand.

2.29 During this interim period, more adequate shop space was provided. HT Building was completed in July 1946, and removal of shops from other buildings was begun. The first was the Uranium Shop from C Building. While this work was in progress, machine tools, benches, and other equipment were arriving for the new Sheet Metal and Heat Treat Shops. The completion date for the final installation of the Heat Treat Shop was delayed until April 1946 because of the difficulty in obtaining even fair delivery dates on bus-bars and the electrical equipment required to operate the furnaces. In November 1945, the new Foundry-Pattern Shop Building was completed and put into operation. The Graphite Shop in Sigma Building was transferred from CMR Division to the Shop Group on November 19, 1945; and in June 1946 the Machine Shop at S Site was placed under the Shops Group.

2.30 On January 16, 1946, Earl Long terminated to accept employment at the University of Chicago, and Gus Schultz took over all phases of the group operation. Shortly before this in December 1945, X-4 (the Engineering Group of X Division), and A-8 (Shops Group) were combined into one group designated as A-3 under the Administration and Services Division.

2.31 Besides the curtailed personnel mentioned above, problems faced the group. In October 1945, a reduction of hours occurred which brought about a decided loss of take-home pay. At this time the project changed from a six- to a five-day work week, and the Shops altered their schedule from a 54-hour to a 48-hour week (9 hours, 36 minutes/day). A coordinated effort was made to effect a wage increase somewhat off-setting this loss, which resulted in an average pay raise of ten cents an hour, effective February 1946, and provided for six nonwork paid holidays and vacation time on a daily instead of weekly basis.

2.32 These regulations certainly gave morale a boost momentarily, but the favorable aspects were almost immediately dispelled by other forthcoming policies. Housing had always been a critical problem and, in the

fall of 1945, a housing control plan was instituted which reduced A-3's allotment. This completely halted the hiring of additional machinists.

2.33 Another discouraging policy was promulgated May 1, 1946, when the \$100.00 monthly incentive pay (Vol. I, 9.46) given to men whose families lived away from the project, was discontinued. This was followed by an announcement of the termination of return travel reimbursement after September 30, 1946 (1.18).

2.34 When the enlisted men in the Shop Group became eligible for discharge, this factor further reduced personnel. There had been a maximum of 120 GI machinists employed. By January 1946 this number had shrunk to 90, and by August 1946 all military had left the group. Although approximately 30 former members of the Special Engineer Detachment accepted offers of employment and returned to their previous jobs as civilians, it still left the group shorthanded and unable to handle the entire Laboratory work load. A system was worked out to have approximately 20 per cent of the plastic and metal machine orders fabricated in West Coast shops. These orders were handled through the Area Engineer's Los Angeles Office. Although the plan relieved Group A-3 of an overwhelming production schedule, the problem was not completely solved. For example, the preparation of proper drawings and descriptions of research items became more involved, and production was delayed the greater length of the time required for shipment of specification and material to and from the Coast.

2.35 In order to simplify control and records of metal stock procurement and issue, the metal stockrooms in the various shops were taken over by Group A-3 from the Procurement Group, and all general issue of metal was transferred from S Warehouse to the Metal stockroom in V Shop in January 1946.

2.36 Concerning technical problems encountered in the shops, mention has been made earlier (Vol. I, 9.51) of uranium machining. The solution of warpage was worked out through a heat-treating method. Further developments in handling uranium were effected through heat treating, and the time element in certain processes was reduced from 3 days to 22 hours.

2.37 By changing steels and through an alteration in the heat treatment, the life of the dies for molding  $U^{235}$  at DP Site was extended, effecting a considerable saving of time and expense.

2.38 Besides the general design and drawing work carried for all divisions, a number of special jobs that constituted steady design load should be mentioned.



2.39 Work begun in 1944 on molds, cutters, and machining fixtures for S Site was carried on constantly. Some of the new designs evolved include: fabricated aluminum molds to replace cerrobased molds; sintered and bonded casting molds; special mixtures and gages for machining high explosive; and various gadgets for S-Site. In October of 1944, the design and fabrication of spheres for use in the radio-lanthanum implosion tests were begun. This work continued as a constant design load for the group.

2.40 In December 1945, the engineering section of the Shop Group was asked by Phillip Morrison to design and construct the central part up to the shielding and the safety mechanisms for a fast reactor to be built at Omega. This was done, and after the first assembly in the fall of 1946, David Hall asked the group to continue the design and supervise the fabrication of the shielding and parts necessary to complete the reactor. This work was still in process at the end of 1946 (4.7).

#### SUPPLY AND PROPERTY GROUP

2.41 After V-J Day the operations of the Procurement Office tended slowly toward channels which were not so devious, because a great many security restrictions had been removed and it was no longer necessary to conceal the fact that the University of California was directly operating the Los Alamos Laboratory. Requisitions formerly sent to one office, to be relayed to another, went directly to the supplying office, thus eliminating duplication of messages and increasing efficiency of operation. Even though channels became simpler, requests for the almost impossible were still rather frequent and as diversified as in the early days.

2.42 Dr. D. P. Mitchell, Assistant Director, who had guided the Procurement Section through the war, returned to Columbia University, and Harry S. Allen was placed in charge of the group on November 1, 1946. This change of supervision occurred almost at the same time the general administration of the Laboratory was reorganized, and the Procurement Group (A-4) became part of the A and S Division (2.8).

2.43 In March 1946, the Procurement Group suffered the same noticeable loss the other Laboratory groups felt, when the military personnel began to leave. Replacements were slow in coming and the new personnel had to undergo a training period, all of which hampered the group in initiating new procedures.

2.44 In April 1946, the Procurement Group was changed to Supply and Property, with the responsibility of property, warehousing, stockrooms, receiving and shipping added to their purchasing activities. Harry Allen was

Group Leader of both functions, with Robert J. Van Gemert Procurement Section Leader; and A. R. Johnson, Section Leader of Property. A heavy load was placed upon the Procurement Section early in 1946, when plans for the Bikini tests were begun.

2.45 It was the responsibility of the Procurement Group not only to purchase needed scientific equipment and apparatus, but to arrange for the specialized packing and transportation of this material.

2.46 The group built stockrooms on both the Albemarle and the Cumberland Sound, which the group completely equipped and stocked. These were manned by personnel from A-4 so that there would be an efficient handling of records and supplies. It is estimated that 300 tons of equipment were purchased by the Procurement Group and moved to proper destination for Crossroads Operation.

2.47 Probably the Property Section, more than any other group, suffered from the early severe restrictions of housing shortage, security measures, and lack of experienced personnel. All of these precluded a tight property system.

2.48 The first Accountable Property Officer for contractor-held property to be stationed at Los Alamos was Lt. William A. Farina, who was sent here July 1, 1945, under the Area Engineer, Lt. Col. S. L. Stewart. He advised Col. Stewart on July 23, 1945, that the account was not operating according to TM 14-910 (the War Department Manual applying to a cost-plus-a-fixed-fee contractor regarding property accounting). At that time, a change of operation could not be incorporated and the group continued as it had been established. Captain (formerly Lt.) Farina was replaced on April 25, 1946, by Captain (later Major) Albert C. Hull, Jr., who accepted accountability subject to correction of discrepancies revealed by a physical inventory when accomplished. No such inventory was taken when accountability was transferred to Major Hull, and he immediately initiated action to bring about corrective measures.

2.49 An audit by the Manhattan District Property auditor (the first ever conducted) was started May 16, 1946, based on a directive from General L. R. Groves. The account was found to be in an unsuitable condition for audit, and a physical inventory was begun in September 1946 under the direction of A. R. Johnson, a staff of fifteen persons, and representatives of Major Hull. All Class B and C property was inventoried. Class A property records were not dealt with inasmuch as these were maintained for the entire Los Alamos project either by the Army or by the service contractor, the Zia Company. The inventory was still in progress at the end of 1946.

2.50 In November 1946, a Property Control Manual was published by the Operating Contractor's Property Section, and after approval by the Army Accountable Property Officer, was distributed to all division leaders, group leaders, and group property personnel for their guidance. The provisions of this manual covered property issues, turn-ins, salvage procedures, disposal of contaminated property, responsibility for property, relief from responsibility, and accounting procedures for certain special items. This manual provided a procedure for those who were not connected with the Property Group and materially aided the Contractor in complying with TM 14-910.

2.51 Also in November 1946, the General Service and Warehouse Section (part of A-4), was placed under the direction of Clyde Reum, and steps were taken for a closer control of stock. A rearrangement of stock rooms and warehouse space was commenced under an accelerated program giving better facilities for storage, shipping, and receiving of goods. Proper accounting records were established for Class C Property at this same time.

2.52 By the end of 1946, this program of progressive steps had been so firmly entrenched that a completely controlled property system was well under way.

#### TECH AREA MAINTENANCE

2.53 This group was known as A-9 until December 6, 1945, when the designation changed to A-5, and it became one of the A and S Division groups under the Associate Director. Its function did not change, however, and it continued to provide maintenance and construction services necessary for the physical operation of the Laboratory, in collaboration with the Army Maintenance Group (Vol. I, 3.120). The Army-supervised craft shops were discontinued February 4, 1946, and Group A-5 became responsible for the entire technical area maintenance program except for power line work, sheet metal work, masonry work, linoleum installation, sprinkler maintenance, placard and sign work. A-5 also absorbed some of the personnel from the discontinued Post group, bringing the organization total up to 244 employees.

2.54 After April 28, 1946, Group A-5 was reorganized. The Zia Company assumed the technical area craft shop work and all but 15 of the original personnel. The group now became a planning body with the following authorized functions:

- (a) Over-all planning of installations in the Technical Area and all outlying sites at Los Alamos.
- (b) Preparation of preliminary plans for new construction in

consultation with representatives of the group or division requiring such construction.

- (c) Submission to the Office of the Associate Director for forwarding to the Post Operations Office all requests for building alteration or new construction.
- (d) Approval of all contract drawings prepared by the Post Operations Office for such work and of all revisions to them.
- (e) Approval of all job orders from authorized Laboratory personnel involving work to be done by Zia Company. This included follow up and coordination on such orders.
- (f) General engineering advice and inspection service in collaboration with the maintenance representatives of the various groups and divisions.
- (g) Initiation of work orders to cover routine maintenance of buildings and grounds in the Technical Areas which are not under the jurisdiction of group or division maintenance representatives.
- (j) General coordination of effort of the maintenance representatives of the various groups and divisions. This included standardization of procedures, interchange of maintenance information, and the calling of regular meetings of maintenance representatives.
- (i) Certain of these responsibilities could, from time to time, be delegated to other competent Laboratory or consultant personnel at the discretion of the A-5 Group Leader where special considerations were involved.

## SAFETY

2.55 Stanley H. Kershaw continued to supervise the Laboratory Safety Group, which had previously been made independent of the Post Safety Section. His group was primarily concerned with the technical aspects of safety and had worked out a closely coordinated safety program with the safety engineer of the CMR Division and the committees set up in other divisions.

2.56 On September 1, 1945, Kershaw left Los Alamos and E. E. Beck assumed his responsibilities. There had always been a certain amount of agitation to centralize all the accident prevention activities of the project. This was finally culminated in an inspection report dated August 28, 1945, from Lloyd E. Blanchard, Consulting Engineer for the Office of Chief of Engineers, to General L. R. Groves. In this report, Mr. Blanchard strongly recommended that there be only one Project Safety Engineer responsible for both Post and the Technical Area planning.

2.57 The recommendation was promptly adopted, and the job of unifying the separate organizations became Beck's primary objective. However, he left the project in December 1945 before the plan had been consummated.

2.58 Centralization was completed in January 1946, and the Post Safety Engineer, Sydney Ingham, became responsible for the adequacy of the Laboratory safety program as well as the Post safety, and was to extend all possible aid to the Technical Areas. In a word, he was accountable to the Commanding Officer and the Office of the Chief of Engineers for all safety and accident prevention at Los Alamos. The position of Laboratory Safety Engineer ceased to exist. The various technical area safety groups and committees organized in the divisions were to continue operation as directed by Ingham.

2.59 Another change in leadership occurred the end of November 1946 when Ingham resigned his post and C. M. Francis became Project Safety Engineer.

2.60 Centralization proved very effective with the only apparent fault lying in a slight tendency on the part of certain division safety committees to lose interest and gradually disintegrate. Although the CMR Division with a full time Safety Engineer, Herbert W. Drager (since April 1945), X-Division, and the Shop Group remained alert and active in their safety programs, the trend in other parts of the Laboratory seemed to indicate the need of a Laboratory Safety Engineer for better integration and coordination.

2.61 The Laboratory accident rates for 1946 showed an increase over those for 1945: in 1945, the Frequency Rate was 6.59 lost time injuries per 1,000,000 man-hours worked; the Severity Rate was 2.49 days lost per 1,000 man-hours worked; whereas in 1946, the Frequency Rate was 6.96 per 1,000,000 man-hours, and the Severity Rate had increased to 8.23 per 1,000 man-hours.

2.62 In December 1946, Conrad W. Thomas became Laboratory Safety Engineer. He was directly responsible to the Associate Director and was specifically assigned the task of setting up a safety program which would result in improved accident prevention measures, adequate accident investigations, reports, and records.

#### PHOTOGRAPHIC GROUP

2.63 The photographic services, except highly specialized technical photography handled by the technical divisions, were an integral part of the Drafting Section, Shop Group, until December 1945. At that time a separate

photographic group came into being as a part of the A and S Division, with John Keller as group leader. He was transferred to Sandia in February 1946, and Loris Gardner assumed leadership.

2.64 It had become apparent that an expansive program was necessary if the group were to take its proper place as a service unit of wide application. With that in mind, a survey was made as to Laboratory needs in the photographic field as well as reproduction methods such as photostat and ozalid. This survey made it possible to order supplies intelligently as well as plan a more efficient use of the available machines. Plans were made at the same time to replace the military personnel who had so ably staffed the photo laboratory during the war years. Arrangements were also started for greater space. Additional equipment was installed throughout 1946, increasing and improving the variety of work produced by Group A-1.

2.65 A new dark room was added to the two already existing. Experiments with new materials were organized: Ozalid Transparent line, Dryphoto, chart film, Heccolith and Heccovel and color prints by Printon. Nearly all of these media met with good response and became part of the group's reproduction functions. A coordination of machines to accomplish given reproduction results was started with good results. For example: the photostat was used to reduce tracings, negatives and positives were then made on the reflex printer, and the resulting foils or transparencies produced in volume on the ozalid. The photographic and microfilm facilities were later used as a beginning function in this chain, selection depending upon the need of fineness of line or upon economic factors.

2.66 It had been recognized early that mimeograph and ditto processes were limited as a means of reproduction for a laboratory of this type. In November 1946 a small offset machine with necessary materials to test its feasibility and economy was ordered. It was a salvaged machine and quite old, but it demonstrated that such a method was flexible, fast, and provided permanent master copies for further use.

2.67 Intensive efforts had been made to improve the black and white prints emanating from the group and to speed up production so that all technical groups could profit from the available facilities. Another successful phase of the group was to assign a photographer from A-1 to different groups for full picture coverage of experiments. Series of pictures were made of the Little Boy assembly, Fast Reactor, DP Site, Bayo Canyon, and other operations.

2.68 Since April 1946, all health records have been microfilmed in triplicate and various medical experiments conducted at Los Alamos have been recorded on film. Perhaps the most spectacular pictures concerning

the health group were the complete photographic coverage, both in black and white, and color, of the effects of the tragic radiation accidents which resulted in Harry Daghlain's death in September 1945 and Louis Slotin's death in May 1946 (2.79).

2.69 Another tremendous piece of work accomplished in 1946 by the Photo Group was in connection with Operation Crossroads. B Division (in charge of the Bikini planning for Los Alamos) had countless drawings, tracings, and other engineering data to be reproduced which severely taxed the facilities of A-1.

## Health Group

### GENERAL

2.70 The Health Group, A-10, was always a Technical Staff Group and after the reorganization of the staff group set-up and the formation of D Division (9.1), it remained the only staff group directly responsible to the Laboratory Director.

### ADMINISTRATION

2.71 The position of group leader fell to several men during the period in question. From August 1945 to October 29, 1945, Dr. Louis H. Hempelmann was in charge; Capt. James F. Nolan, M.D., succeeded Dr. Hempelmann, who was appointed as medical consultant to the project. In March 1946, Dr. Nolan relinquished his position and along with Dr. Hempelmann transferred to activities in connection with Operation Crossroads. Dr. Nolan was succeeded by Capt. Harry O. Whipple, M.D., who continued in this position until August 14, 1946. At that time, Dr. Louis Hempelmann returned to the group from Bikini and again assumed duties as group leader.

### FUNCTIONS

2.72 The group was particularly involved in two phases of the work, in addition to its former and more routine duties (Vol. I, 3.87). These were:

### Termination Procedures

2.73 Because of the exodus of the greater proportion of the Laboratory personnel through discharge from the Army or through return to peacetime pursuits, the Health Group had an enormous load. Oftentimes other functions of the group were limited in order to make use of the opportunity for interview and for physiological tests requested at the termination of these individuals. Adequately staffing the hematological and clinical laboratories created a problem, because this personnel was also terminating.

2.74 It was believed, however, that the termination procedure was most important for completing records and establishing some record in the many cases of workers whose names were not even listed in the health files. These files are the records for the protection of individuals as well as the project, and much effort had been expended in their reorganization. Photo-static copies were made to minimize the detrimental effects if they were lost or destroyed.

2.75 Dr. Wright Langham, head of the Biochemistry Section, asked for urine assays of plutonium workers who were terminating. Oftentimes, the time between notification of discharge and leaving the Post was short and there was often very little cooperation on the part of individuals about to be discharged.

2.76 The hematological laboratory had been so pushed most of the time that (a) counting techniques were not rigorous (200 cells instead of 500 on Differentials, 1 pipette for white blood counts and red blood counts instead of 2 pipettes); (b) some workers did not obtain counts as often as every 4 to 6 weeks, as desired by group leaders and the Health Group; (c) development work on the hematological picture in radiation exposures in human beings (Dickie granules) was suspended.

### Reorganization of the Health Group's Functions

2.77 With the lifting of security and the lack of pressure by the war, employees at Los Alamos Laboratory now were concerned about the special hazards. It became necessary, for the protection of the contractor and for the morale of the worker, to do things which were desirable but not absolutely necessary for the protection of the worker's health. Nurses were employed in the first aid rooms of outlying sites rather than G. I. first aid men. The nurses helped carry out routine health procedures beside making a record of minor accidents and toxic disturbances. Another nurse and aid room was established in the Technical Area to care for minor shop accidents, although the Station Hospital was nearby.



2.78 Another attempt along this line had been to routinize more of the Health Group activities. Dr. J. G. Hoffman's Health-Physics Section put the distribution, collection, development, and recording of film badges used in certain areas on a more routine basis. Equipment and techniques were being developed which allowed this function to go on more automatically. The work was arranged so that it could be done by less skilled technicians and more records obtained. Actual negative results were obtained upon which to base recommendations, rather than the unsupported opinion of the worker that very little radiation was encountered in his operations. With these routine methods, enforcement methods were made easier for the varied operations engaged in.

2.79 Reporting of critical assembly activities to the Health Group was requested. Accidents in this field, particularly the radiation accident fatal to Harry K. Daghljan, September 15, 1945, convinced those in charge that the Health Group should be somehow represented in these operations. Louis Slotin, the Group Leader in charge of critical assemblies, after conference, agreed to assign one man from his group to report to J. G. Hoffman on monitoring activities. However, failure to obey the established regulations resulted in an accident on May 21, 1946, at Pajarito Site, during a critical assembly of fissile material. Present at the time were Louis Slotin and seven others. As a result of this accident Slotin died, and three others required intensive follow-up care. The clinical care of all of these men was under the direction of Dr. Paul Hageman; and the services of Dr. Louis H. Hempelmann, then at Washington University, St. Louis, and loaned to Operation Crossroads, were secured as special consultant. The Health Group followed closely the hematology and the induced activities in blood and urine of these men (5.11, 5.15).

2.80 Activities with radiolanthanum at Bayo Canyon were limited by policy which tended to forego the experiment if exposures became high and also to limit the amount of material with which the personnel could work.

2.81 The Biochemistry Section under Dr. Wright Langham attempted to establish a routine method for urine assays for plutonium on all CMR personnel (6.44). This involved decontamination of his laboratory, allocation of hospital space, and development of supervision in collection of samples. It was entirely possible that the sensitivity of this assay might make the physical set-up impractical for routine use. It was anticipated that his phase of the work should be moved out of the main Technical Area entirely, especially if a new hospital was built. A "milk-route" was established to obtain specimens from the homes of polonium workers because they were most uncooperative in furnishing them without supervision. Secretarial aid was obtained to assist the hematological group in the notification of personnel to

report for blood counts. Also routine trips were taken to outlying sites to obtain blood specimens so that individual responsibility might be minimized.

2.82 Film badge monitoring increased during the period and it became necessary to expand facilities for the routine processing of films. The existing darkroom in Q-building was quite inadequate, and considerable time and effort were spent in the design and construction of a new darkroom in which the processing of personnel monitoring films could be efficiently carried out.

2.83 External radiation hazards were, for the most part, well controlled. However, arrangements for discharge of fission products from the Water Boiler were unsatisfactory and represented a potential health hazard. Two recommendations were made: 1) Fence the immediate area; 2) Undertake studies for a method of disposal of this material without creating either a hazard or a nuisance to the Laboratory. It was thought that release of this material through a stack high enough to avoid ground turbulence might be a solution.

2.84 Consideration was being given to the problem of a major catastrophe involving radioactive materials. Though a hazard is admittedly slight, it was felt that plans should be made for handling a situation in which a major portion of this area might become contaminated with radioactive material. Supplied-atmosphere masks and monitoring instruments were being assembled for equipping an emergency vehicle.

2.85 There were two additional group activities, outside the routine categories, which were time consuming and deserve mention:

- (a) Crossroads Activities. Although this group had no direct involvement in preparations for this test, Dr. Hempelmann, Dr. Nolan, Dr. Hoffman, and Dr. Langham spent some time on arrangements and conferences. Dr. Hempelmann, with the help of Dr. Langham, Dr. Hoffman, and Captain Large, gave a two-week course in basic physics and radiation problems of atom bomb tests to a group of Army, Navy, and Public Health doctors on the staff of Col. Stafford Warren. Dr. Hempelmann and Dr. Hoffman made trips to Washington and Rochester for conferences. Colonel Warren came to the Project several times for conference and planning. Drs. Hempelmann, Langham, and Nolan actually took part in these tests as monitors.
- (b) Trinity Activities. Dr. Hoffman's group took several trips to Alamogordo Area to obtain additional information for decay curves on radiation from the July 16, 1945, test. Dr. Hempelmann continued

the studies of physiological effects of the radiation on cows purchased from that area and brought to this site. The hematology group spent a great proportion of their time doing hematological studies on these cows. These activities were practically terminated at the end of 1946.

## Business Office

### INTRODUCTION

2.86 The Business Office of the Laboratory was the direct representative of R. M. Underhill, Secretary and Treasurer to the Regents of the University of California (Vol. I, 3.59-3.68). As such, it had a special interest in all phases of the Laboratory operations. However, this special interest based on the contract between the University of California and the Manhattan Project gave a substantially different viewpoint on the operation of the Laboratory. It seems only proper to review certain phases of the history from this vantage, even though some repetition might result.

### LABORATORY PAYROLL

2.87 During the year and one-half preceding 1947, the average monthly payroll of monthly-rated employees had increased from approximately \$200,000 in July 1945 to a high of \$437,750 in April 1946 (a sharp jump of about \$160,000 occasioned by Operation Crossroads) and then slowly reduced to a payroll of \$300,000 in December 1946.

2.88 The payroll of hourly employees had been about \$125,000 in July 1945 because of the Alamogordo test of the atomic weapon. This payroll dropped to a low of approximately \$36,000 in December 1945, and then slowly rose to \$63,000 in December 1946.

2.89 The entire payroll of both monthly and hourly employees seemed to remain relatively close to a monthly average of \$360,000 throughout this period, with a peak of over \$500,000 in the month of April 1946.

### TIME AND ATTENDANCE REPORTS

2.90 The practice of time reporting by individuals as handled by the Personnel Department was discontinued effective March 4, 1946. At that

time the Director approved the attendance reporting form now in use, which is forwarded to the payroll office weekly, indicating each day-work by each employee and signed by a responsible person within the respective group. The information from these time reports is posted weekly to Kardex records, and on the 10th of each month a schedule of days to be deducted from the checks of monthly-rated employees is sent to the Los Angeles office. The Los Angeles payroll office then writes the checks for the monthly employees, making deductions only where this office so instructs. In the case of hourly-rated employees, payments are made by this office based directly upon the positive time recording of actual hours worked.

### TRAVEL DISBURSEMENT

2.91 During the period July 1945 through December 1946, \$683,312 was disbursed for official travel of project employees, an average of \$37,962 per month. The peak month was March 1946, which totaled \$83,450, occasioned by the sending of a large number of project employees overseas in the Crossroads Operation. The second highest month was September 1946, which totaled \$73,500, occasioned by the last rush of terminees who left the project before the September 30th deadline on the payment of return travel.

2.92 The practice of issuing checks on travel expense accounts by the Los Angeles office was generally discontinued in August 1945. A few checks were issued each month through May 1946 by Los Angeles, but none have been issued by that office since that date.

2.93 The tremendous load of outstanding travel accounts during the months April through September 1946 placed the travel office in the position of facing a huge backlog of several hundred thousand dollars and became a problem of major proportions. Consequently, the foundation was laid to strengthen the organization of this section with individuals having more than rudimentary clerical experience. This program of building up with the aid of persons actually experienced in travel and transportation matters was well under way by the end of December 1946.

### LOCAL EXPENDITURES - OTHER THAN PAYROLL AND TRAVEL

#### (a) Purchasing

2.94 For the period in question, the monthly local purchases averaged \$4,301.03. The peak month was July 1945, with a total of \$14,061.37, occasioned by purchase of materials needed for the Alamogordo test. The low

month was November 1945, at a figure of \$1,538.37. Local purchases were nearer to the average during the last half of 1946, at which time purchasing included material for the Technical Library, the KRS radio station, and the paper and printing for the Los Alamos Times. Local purchases also included gases, stationery and supplies, dry ice, commissary items, and other miscellaneous emergency items.

(b) Consultant Fees

2.95 Payment of consultant fees by the Business Office began in July 1946. The average payments for the last six months of 1946 was \$3,048.19. The peak month was October 1946, at a total of \$8,003.22.

(c) Advances (not including travel)

2.96 After six months of continuous service, all employees were automatically included in the California State Employees Retirement System (SERS). Payroll deductions were made monthly for deposit to this fund. A wartime emergency provision under this system made it possible for employees, when severing from the University of California, to fill out a power-of-attorney to the University of California in order that immediate payment could be made to the employees by the University of California for the amount of monies withheld from their salaries and deposited in their account under SERS. The University of California in turn presented the power-of-attorney to the State of California Retirement System to recover the money so advanced by the University of California to the severing employees.

2.97 The monthly advance payments from the payroll office averaged \$598.62. The peak month was September 1946, with \$2,663.28 average, chiefly SERS advances.

(d) Services

2.98 Payments for miscellaneous services included utilities, rent, freight, laundry, telephone and telegraph. The average monthly payment for this period was \$3,966.17. The peak month was August 1945, with a total of \$29,303.84, chiefly freight charges. There was a steady decrease in payments for services from August 1945, due to the change-over in handling of freight (from cash payment to handling on Government Bill of Lading). After May 1946 the freight payments were negligible.

(e) Miscellaneous

2.99 Other local expenditures for this period included hospital subsistence for employees on health passes or under treatment for job-incurred injuries; contract nurse subsistence; payments to blood donors of injured employees; and other emergency payments including one \$10,000 Welfare

Fund payment to the mother of Harry Krikor Daghljan, which payment was made directly from the Business Manager's Revolving Fund (2.114). The average of monthly miscellaneous payments was \$680.10. The peak month was September 1945 with the payment of \$10,000 referred to above

#### ADDITIONAL ACTIVITIES OF THE BUSINESS OFFICE

##### Check-Cashing Facility

2.100 Another function provided by this office was the check-cashing facility (Vol. I, 3.66). The following statistics indicate the volume of transacted business:

##### Monthly record-

Average month: \$101,610.20  
Peak month: 121,024.31 - October 1945  
Low month: 78,265.51 - February 1946

##### Daily record -

Average day: 4,467.58  
Peak day: 21,799.55 - August 2, 1946  
Low day: 887.85 - October 16, 1946

##### Trend:

There has been a slight but steady increase during the last half of 1946, which is probably due to the relaxing of security regulations which required that the pay-checks should be mailed direct to the individual's bank.

The heaviest days are usually the 1st and 2nd of the month.

The lightest day is approximately the 20th of the month.

##### Revolving Fund

2.101 The Revolving Fund of \$50,000 maintained in the Business Office included the following constant figures:

\$25,000.00 check cashing service  
15.00 for petty cash, Santa Fe office  
25.00 petty cash for nursery school  
500.00 war bond account  
125.00 U. S. Postal stamps - mail room  
15.00 petty cash in Housing Office for small  
express bills. (This sum was increased to  
\$25.00 in August 1946.)

Because of the added expense in connection with the Crossroads Operation, the total fund was increased to \$65,000 for September 1946.

#### The McNierney Cattle Case

2.102 On August 25, 1946, \$1,350 was paid to W. L. McNierney as compensation for loss suffered by him in connection with the sale of 140 head of cattle at reduced market value during September 1945 as the result of discoloration of cattle hair alleged to have been caused by exposure during the test at Alamogordo, New Mexico, on July 16, 1945.

#### Telephone and Telegraph

2.103 For reasons of security, payment of telephone and telegraph services was handled through the Business Office. All bills from Western Union, Railway Express (which handled much of the telegraphic service in order to assist us in maintaining security), and from the telephone company were billed to the Business Office, that office in turn collecting the amounts due from the various employees. This practice was discontinued as of the last of May 1946 after the relaxing of security regulations, inasmuch as it was then deemed safe to establish such accounts in individual names of employees at the Project.

#### Nursery School

2.104 Financing of the nursery school was handled through the Business Office. It was the duty of that office to collect from the parents of the children enrolled the tuition and the fees for lunches served. The Business Office in turn paid the school teachers, the food bills, maid service, dietician, and other bills. Such services as nurse, janitor, utilities, buildings, and laundry were not chargeable to the budget but were subsidized by the Government. The school continued as a responsibility of the Business Office until December 1, 1946, at which time it was directed by Colonel A. C. Nauman, in his letters of October 30, 1946, and November 25, 1946, that responsibility for operation of the nursery school (a part of Community Services) would be assumed by the Zia Company effective December 1, 1946.

#### Newspaper

2.105 As of June 21, 1946, the local newspaper, the Los Alamos Times, was handled by the Laboratory. The New Mexico Publishing Company, in

Santa Fe, printed the weekly issues. The printing bills were paid through the Business Office. By letter of October 30, 1946, Colonel Arthur C. Nauman, Representative of the Contracting Officer for the Zia Company, directed that, effective November 1, 1946, the Zia Company would assume responsibility for operation of Community Services, including operation of the Los Alamos Times (2.23).

#### Radio Station

2.106 Similar to the maintenance of the newspaper was the establishment and operation of the local radio station, KRS. The expenses incurred in this connection were paid by the Business Office and included such items as news service, records, equipment, special directors' salaries, etc. Operation of the radio station was begun in February 1946 and was handled by the Laboratory until November 1, 1946, at which time the contract was transferred to the Zia Company pursuant to letter of October 30, 1946, from Colonel Arthur C. Nauman (2.25 ff).

#### United Press Associations - New Service

2.107 By contract agreement dated June 8, 1946, between the United Press Associations and the University of California Los Alamos Laboratory, it was agreed that the United Press would furnish leased radio wire and news reports to the Laboratory for use in broadcasting over Radio Station KRS and for printing in the Los Alamos Times, which news reports were to be delivered to the broadcaster by leased wire and teletype. Payment for this service was made by the Business Office through November 30, 1946. On December 10, 1946, a formal assignment of this contract agreement was made by the Regents of the University of California to the Zia Company pursuant to directive dated October 30, 1946, from Colonel Arthur C. Nauman, Representative of the Contracting Officer for the Zia Company, in which he instructed that responsibility for operation of the community services (which included the KRS Radio Station) would be assumed by the Zia Company.

#### Hospital Employees

2.108 During the period when the local hospital was under the direction of the U. S. Engineers, many of the nurses serving there were under Laboratory contract. It was felt that in accordance with the practice in other nearby hospitals, the nurses should be furnished one free meal for each eight hour duty period. The Laboratory consequently reimbursed the U. S. Engineers for daily subsistence of one meal for each eight hours of



duty for each nurse. A like responsibility was the daily subsistence for employees ordered to the hospital for one-day health passes. An allowance of \$1.00 per day was made for these charges. By letter of May 29, 1946, Lt. Col. W. A. Stevens, Authorized Representative, Contracting Officer, for the Zia Company, directed that effective June 16, 1946, the Zia Company should assume responsibility for operation of the Post Hospital and that the nurses and technicians in the employ of the hospital should transfer to the Zia Company payroll under Contract W-17-028-Eng-90. At that time the nurses' contracts were also transferred to Zia, and the Business Office was thereby released from payment of such meal subsistence bills. Subsistence for those on health passes, however, has continued to be paid by the Business Office inasmuch as these individuals are employees of the Laboratory (2.20).

### School

2.109 Superintendent and school teachers for the grammar and high school were carried on the Laboratory payroll until June 1946, at which time they were transferred to the Zia Company operating under Contract No. W-17-028-Eng-90, in accordance with directive dated May 25, 1946, from Lt. Col. Stanley L. Stewart, Area Engineer (2.20).

### Library

2.110 For obvious security reasons, all orders for the Library had been made through Los Angeles, and the publications were routed to the Los Angeles warehouse. At Los Angeles the publications were processed and forwarded to Los Alamos. In April 1946 it was determined that all monographic and serial publications ordered by the Berkeley Accessions Department at the request of the Project Librarian should be mailed direct from the publisher or vendor to the Library. It was believed that this change in procedure would expedite the arrival of publications at the Library; would promote more efficient and economical operations by direct mailing to the project subsequent to the lifting of security regulations; would relieve the Los Angeles warehouse of the processing of Library receipts and shipments; and would relieve the Los Angeles Purchasing Department of handling Library purchase orders placed from outside the local campus.

2.111 This change in procedure was so successful that in May it was decided that further Library control should be moved to the project from Los Angeles. Plans were then made to have the Business Office take over the control of Library purchasing and payment of the invoices covering the purchases. The transition was, of course, rather slow, covering a period of

several months. By the last of June 1946, all orders for the Library were made by local purchase orders. The Librarian prepares the orders for material desired and forwards them to the Business Office for approval. Here they are carefully processed, care being taken to ascertain that all such purchases are made within the rules of the Laboratory. Local files were set up by vendor name to provide the necessary records and materials for payment and follow-up of the orders. Vendors are requested to invoice direct to the Business Office, addressing the invoice to the Business Manager by name. Payment is made from the Business Office, drawn on the Revolving Fund. Until arrangements could be made with our bank in Santa Fe to handle foreign drafts, we continued to forward invoices of foreign companies to Los Angeles for payment. In December 1946, the bank notified us that they were prepared to issue foreign drafts, and the Business Office thereupon assumed the payment of these bills.

2.112 In view of the fact that the Business Office maintained files by vendor name as well as by purchase order number, it was decided in December 1946 that the matter of expediting purchases could be more readily handled in the Business Office than in the Library. A follow-up system of 60 days was instituted on most orders, and 90 days on a few which presented unusual circumstances, and carried through by the accounts-payable desk with the cooperation of the Librarian.

2.113 Thus, by the latter part of 1946 the Project was handling locally all of the work and problems in connection with the Technical Library. The majority of "kinks" resulting from the transition (such as mis-mailing, duplications, or erroneous cancellations) had been ironed out, and the Library and the Business Office agreed that the new system was quite satisfactory.

## COMPENSABLE INDUSTRIAL ACCIDENTS - JULY 1945 TO JANUARY 1946

### Workmen's Compensation and Welfare Benefits

2.114 At 9:55 p.m. on August 21, 1945, Harry Krikor Daghlilian was fatally injured while working at Omega Laboratory (5.11). He lived for 25 days after the accident, and death occurred at 4:30 p.m. on Saturday, September 15, 1945. He was survived by his mother, a sister, and a brother, his father having died in 1943. His mother and sister were at the project at the time of his death on September 15. On that day, the Board of Regents of the University of California was authorized by the Area Manager to make immediate payment from the Welfare Fund of \$10,000.00 in the case of Harry Krikor Daghlilian. Upon instructions to this effect, the Business

Manager at the project delivered to Mr. Daghljan's mother a check from his Revolving Fund in the amount of \$10,000.00 before Mrs. Daghljan's departure from the project on September 16.

2.115 No death benefits under the Workmen's Compensation Act were due in this case, as Mr. Daghljan left no dependents.

2.116 During the year 1946 there were 195 occupational accident cases occurring to Laboratory employees, of which fifteen were determined to be compensable.

2.117 Five of these accidents, while they may not have been classified by the injured individuals as "minor," nevertheless would not in any sense be termed "critical," nor did they result in permanent disability. These five cases were compensated by a total of \$149.27 under the Workmen's Compensation Laws of the State of New Mexico.

2.118 Another accident, which occurred in May 1946, involved seven of these fifteen compensable cases. All of these men received some degree of injury, and one, Dr. Louis Slotin, was fatally injured (5.15). Dr. Slotin, along with the other six men, was conducting an experiment at Pajarito Laboratory on May 21, 1946, when the accident occurred. Dr. Slotin expired on May 30, the ninth day after the accident. He was survived by his parents, a brother, and a sister. Subsequent to the accident, his parents were called to visit him. Arrangement were made for payment of their travel to Los Alamos and return to Winnipeg, Canada, through Government funds, and this matter was turned over to Major Sidney Newburger, Post Intelligence Officer, for handling. Their lodging and meals while at the project were paid in the same manner. Medical and shipping expenses in connection with Dr. Slotin's death were borne by the Laboratory. A maximum settlement under the Welfare Fund was made in the case of Dr. Slotin, and the payment of \$10,000 was made to Mrs. Sonia Slotin, mother. Due to the fact that Dr. Slotin left no dependents, his case was excluded under the Workmen's Compensation Laws. No final medical opinion can be made in the cases of the other six men involved, pending some further observation of this type of injury, and for that reason their cases await determination as to what, if any, settlement should be made under Workmen's Compensation. In the cases of two of these men, it may be determined that some degree of permanent disability exists.

2.119 In a smoke-bomb explosion accident at Omega which occurred on August 2, 1946, three men were involved. One of these men, Joshua I. Schwartz, was fatally injured. The other two men received permanent injuries: the accident to one resulted in total blindness; the injury to the other was determined to be almost total blindness in that he is industrially and economically blind, having suffered total loss of sight in one eye and

injury to the other eye to the extent that only light perception remains. In the case of Mr. Schwartz, the maximum Welfare Fund settlement was made in the amount of \$10,000. No compensation was awarded in his case under the Workmen's Compensation Laws inasmuch as he left no dependents. In the case of the injured men, the maximum Workmen's Compensation settlement has been agreed upon for one in the form of \$18 per week for 550 weeks (a total of \$9,900). It is expected that a similar decision will be reached in the case of the second man. Determination of welfare payments in both of these cases is not yet complete.

### Public Liability

2.120 On January 31, 1946, a Laboratory employee, Philip Lawson, while on official duty, was driving between two housing units on the project. Two children, who were playing in the yard, moved over near the driveway behind Lawson's car as it backed out toward the road. The side of the car hit the children. One child was unhurt; the other, Dennis Roth, age 3, received minor cuts and bruises and a fracture to his foot. Mr. Lawson immediately took the child and his mother to the hospital where examinations and x-rays were made. Dennis Roth was hospitalized overnight at the project and taken to Bruns General Hospital in Santa Fe the next morning, at the request of his father, Captain Lloyd Joseph Roth, AUS. The Bruns doctor recommended that the boy wear a short-leg cast for about three weeks, and stated that no permanent disability was likely. Within a few weeks the child's foot had healed completely. Captain Roth and his wife, Mary Jane Roth, then made formal request that some compensation settlement be made for their care to the child and the inconvenience suffered on account of the accident. By letter of June 10, 1946, Mr. Underhill stated that this matter was covered by Globe Indemnity Company Policy No. 500350, and that the case should be handled expeditiously. Accordingly, Globe Indemnity Company check in the amount of \$275.00 was tendered to the Roths and proper indemnifying release secured for final settlement.

2.121 To date, this is the only public liability case which it has been necessary that the University of California settle at this project.

### INSURANCE

#### Master Policy FD-502

2.122 In June 1945, it was announced that the Contractor's Representative under Contract W-7405-Eng-36, could take applications for Indemnity

Insurance Company of North America Policy FD-502, for Contractor's employees regularly assigned to work on the project. Certificates of insurance issued under this policy were for \$10,000, which principal, however, could be increased to a maximum of \$20,000 or decreased to a minimum of \$5,000.

2.123 The certificates of insurance were purchased by employees individually, and were frequently referred to as "crossroads insurance" inasmuch as policies were purchased by approximately 80 employees detailed to the Bikini test program in May 1946.

#### Group Hospitalization Insurance

2.124 On June 30, 1946, free hospital and medical service for project employees was discontinued. As a result of this action, a committee was appointed by the Director to study and recommend a plan of group insurance to assist the employee in meeting his hospital, medical, and surgical expenses.

2.125 This committee recommended a plan offered by the Business Men's Assurance Company as the one offering the most complete coverage at the least cost and, in general, best suited to the particular needs of the project employees.

2.126 After a careful study of the plan, the Business Manager, Mr. A. E. Dyhre, approved it and agreed that a payroll deduction plan would be set up to handle the premiums for all participating employees. This meant setting up and keeping, roughly, 1,000 new records by the Payroll Section. This group plan was then presented to the project employees for their approval. The plan was put into effect July 15, 1946, with a large majority of the employees signing up as participants. This payroll deduction plan has been found to work quite smoothly and there has been no reported difficulty with the Company.

#### GENERAL

2.127 When Mr. Dyhre (Business Manager) and L. G. Hawkins (Assistant Business Manager) assumed management on June 1, 1946, the Business Office consisted of a total of 17 employees. At the end of December 1946 the total was 23. The increase in the number of personnel was in the Travel Section, occasioned by the very heavy load described in paragraph 2.91. The other divisions of the Business Office did not increase or decrease in personnel during this period.

## Chapter III

### THEORETICAL PHYSICS DIVISION

#### Introduction

3.1 During the third period, August 1945 through the year 1946, the Theoretical Division continued its war-time program with certain modifications and on a reduced scale, and added to its interests the theoretical physics research on thermonuclear systems formerly carried on in F Division (Vol. I, 13.3). In the fall of 1945, much attention was given to the complex hydrodynamical problems involved in the interpretation of the blast measurements made at Trinity, Hiroshima, and Nagasaki; also, during this time, much effort was spent on the radiation hydrodynamics of the implosion fission bomb.

#### Organization

3.2 The difficulties of the early interim period affected Theoretical Division seriously. Of the division leader and the eight group leaders serving in August 1945, all had left by September 1946; early in this period most of the junior members of the division returned to the universities to resume their interrupted studies. The group structure of the division in August 1945, together with the date of termination of regular employment of the group leader, was as follows:

<u>Group</u>	<u>Group Leader</u>	<u>Termination of Regular Employment</u>
T-1 Implosion Dynamics	R. E. Peierls	January 1946
T-2 Diffusion Theory	R. Serber	November 1945
T-3 Efficiency Theory	V. F. Weisskopf	February 1946
T-4 Diffusion Problems	R. P. Feynman	October 1945
T-5 Computation	D. A. Flanders	September 1946
T-6 IBM Computations	E. Nelson	January 1946
T-7 Damage	J. O. Hirschfelder	August 1946
T-8 Composite Weapon	G. Placzek	May 1946

Many of the above-named group leaders were retained in consultant status.

3.3 On November 14, 1945, Group F-1, which had been part of Theoretical Division up to June 1944 (Vol. I, 13.3), returned to Theoretical Division and became Group T-7. As before, its concern was the theory of thermonuclear systems.

3.4 On December 1, 1945, Hans A. Bethe resigned as Theoretical Division Leader and shortly thereafter returned to his position at Cornell University. His successor was George Placzek, who had joined the Theoretical Division in May 1945 after working for several years with the Montreal group.

3.5 Early in 1946, a general reorganization took place, and the resulting group structure on January 8, 1946 was as follows:

<u>Group</u>	<u>Group Leader</u>	<u>Termination of Regular Employment of Group Leader</u>
T-1 Hydrodynamics	Joseph M. Keller	June 27, 1946
T-2 (Group dissolved; personnel transferred to T-8)		
T-3 Efficiency Theory	V. F. Weisskopf	February 28, 1946
T-4 Diffusion Problems	R. Ehrlich	January 9, 1946
T-5 Computations	D. A. Flanders	September 4, 1946
T-6 IBM Computations	R. W. Hamming	June 24, 1946
T-7 Super	E. Teller	January 21, 1946
T-8 Diffusion Theory	C. Mark	Did not terminate

3.6 The return of key personnel to the universities for the spring semester in 1946 necessitated considerable change. Groups T-2, T-3, and T-4 were dissolved and the personnel were transferred to the remaining groups.

3.7 Work on radiation hydrodynamics formerly carried on by Group

T-3 became the concern of R. Landshoff, a member of Group T-7, who in May 1946 visited Ithaca, Rochester, and Boston to discuss this work with former members of Group T-3. Group T-1 was dissolved in June; some of the problems worked on by this group were distributed among the remaining groups. A new group, T-1, was formed under the leadership of F. Reines to consider the theory of the dragon (3.21) and to work on blast wave and damage problems which might arise. All computations, both manual and machine (IBM), became the concern of a group under D. A. Flanders. In anticipation of Mr. Flanders' leaving, Bengt Carlson became group leader of a new group, T-2, on August 14, 1946.

3.8 Operation Crossroads, which seriously affected the work of some other divisions, did not add to the personnel problems of T-Division. J. O. Hirschfelder and J. L. Magee, both of whom were with Group T-7 (Damage) until their resignations in the fall of 1945, returned to devote full-time attention to Operation Crossroads problems in the spring and summer of 1946.

3.9 On May 20, 1946, G. Placzek became ill and left Los Alamos on a leave of absence. He could not return to the project because the high altitude affected his health; however, he was not terminated until July 9, 1946. Robert D. Richtmyer, who had transferred from the Patent Group, acted as Division Leader for the Theoretical Division until November 1946 when he became Division Leader.

3.10 In the summer of 1946 a group of consultants aided the work of Theoretical Division. This group included E. Fermi, F. Hoyt, and E. Teller of the University of Chicago; Lothar Nordheim and Gertrud Nordheim of Clinton Laboratories; R. Marshak of the University of Rochester; R. P. Feynman of Cornell University; J. O. Hirschfelder, University of Wisconsin; J. von Neumann, of the Institute of Advanced Studies, Princeton University; V. Weisskopf, T. Welton, of the Massachusetts Institute of Technology. With the exceptions of Mr. and Mrs. Nordheim and Mr. Hoyt, all were members of the wartime staff of Los Alamos.

3.11 In the fall of 1946, S. Ulam, who left Group F-1 in 1945 to join the staff of the University of Southern California, returned to Los Alamos to become group leader of a new group whose concern was general mathematical methods. L. Goldstein, formerly of the College of City of New York, and the Division of War Research, Columbia University, joined the T Division Staff at about the same time.

3.12 A group was set up in the Fall of 1946 under the leadership of R. D. Richtmyer to study the new thermonuclear system proposed by E. Teller.



3.13 The group structure of Theoretical Division at the close of the third period, December 1946, was as follows:

T-1	Theory of Dragon	F. Reines
T-2	Computations	B. Carlson
T-3	Super and Radiation Hydrodynamics	R. Landshoff
T-4	Diffusion Theory	C. Mark
T-5	IBM Computations	B. Carlson (Acting)
T-8	Mathematical Methods	S. Ulam
T-9	Advanced Designs	R. D. Richtmyer
T-10	Fundamental Nuclear Physics	L. Goldstein

### Effects of Test and Combat Nuclear Explosions

3.14 Interpretation of observations of the July 16, 1945, test explosion at Trinity and of the combat explosions at Hiroshima and Nagasaki made up much of the activity of Theoretical Division in the early fall of 1945. A theory was developed by Group T-1 for estimating the energy release of a fission bomb explosion by consideration of the expansion velocity of the ball of fire in its early stages; this theoretical treatment differed from earlier ones in that it considered the effect of the high density material of the bomb (and at Trinity, its supporting platform and housing) on the pressure distribution. In an attempt to eliminate the uncertainty (Vol. I, 11.14) concerning the proportion of energy released by a fission bomb which is converted into blast energy, a calculation (Problem M) using the IBM machines was made; the blast energy resulting from the explosion of a fission bomb was found to be about two-thirds that resulting from the explosion of a corresponding amount of TNT. Based on further study using blast and optical data, the final analysis by Group T-1 gave as the most probable values for the nuclear energy release the TNT equivalents of 20,000 tons for Trinity, 15,000 tons for Hiroshima, and 50,000 tons for Nagasaki; the value for Nagasaki was more uncertain than the others.

### Radiation Hydrodynamics

3.15 The unexpectedly high yield of the Trinity explosion (Vol. I, 11.19) led to a renewal of the early speculations (Vol. I, 5.40) about the simplifying

assumption (Vol. I, 5.34) of neglect of radiation made in the original efficiency calculations.

## Super

3.16 At the close of the war, Group F-1 (which became Group T-7 on November 14, 1945) was relieved of its responsibilities connected with the design and testing of fission bombs and was able to devote full-time attention to bombs based on thermonuclear processes. E. Fermi summed up existing knowledge on relevant thermonuclear processes in a series of six lectures given in July, August, and September 1946. The period of intensive activity of this group came to an end by June 1946 when the work was curtailed through serious loss of personnel.

## Super Conference

3.17 In April 1946, a conference of members of Group T-7 and other Los Alamos staff members and consultants concerned with the development of thermonuclear bombs took place (1.21). The work on thermonuclear processes was reviewed, and a specific model of a thermonuclear bomb was considered.

3.18 An account of the fundamental physical processes of importance to the thermonuclear bomb is presented in Vol. I and will not be repeated here. The conference, although it examined this fundamental work for completeness and accuracy, centered its attention on the feasibility of the specific model presented by Group T-7. Proposals and suggestions regarding basic theoretical investigations grew from examination and consideration of this model.

3.19 The model proposed was chosen for amenability to theoretical treatment rather than for engineering practicability or efficient use of precious material. This followed from the purpose of the conference, which was to study the feasibility of thermonuclear bombs in principle, and not to propose designs for actual weapons.

## Power Producing Devices

3.20 Two power-producing devices were considered by the Theoretical Division during the period following the end of the war through the year 1946.

### REPETITIVE DRAGON

3.21 The first was a device proposed and considered by F. Reines of Group T-1, which because of the features it had in common with mechanism used in the "dragon" experiment (Vol. I, 15.7 ff), was called the "repetitive dragon." It consisted of a machine which periodically placed pieces of active material, either metal or hydride, in such positions that for a short time they formed an assembly critical with respect to prompt neutrons. The device would have considerable use as a research tool, and could be used for the production of power. Extreme accuracy is demanded of the mechanical assembling device to keep fairly uniform the bursts of power, which vary exponentially with the length of assembly; use of the hydride, in which the mean time between fissions is about one hundred times that of the metal, would permit somewhat greater tolerance in the mechanism.

### FAST REACTOR

3.22 A second power-producing "fast" reactor was worked upon by C. Mark of Group T-8 with the help of the computation groups T-2 and T-5. Although R. P. Feynman first suggested this type reactor in 1943, this specific reactor was proposed by P. Morrison and is described elsewhere (4.7). It consisted of a fairly complex arrangement of plutonium rods, coolant, and tamper, which formed critical assembly for neutrons with fission-spectrum energy. Using a modification of the diffusion-theory methods developed for determining the criticality of the simpler assemblies considered in bomb design, Group T-8 was able to determine accurately the critical dimensions of the assembly.

## Chapter IV

### PHYSICS DIVISION

#### Formation of P-Division

4.1 The Research Division under R. R. Wilson, (Vol. I, Chapter XII) and the F Division under Enrico Fermi, (Vol. I, Chapter XIII) continued experimental work throughout August and September 1945. Both divisions were greatly concerned over the problems of establishing a post-war program, and both suffered the same unrest. Thus no especial advances in research resulted. Before Dr. Wilson left the laboratory he recommended that the Research and F Divisions be combined into a single unit known as the Physics Division. In a letter on October 31, 1945, he expressed the thought that the "work performed by these two divisions plus the inclusion of the fast chain reactions were particularly important to give the new Research Division a solid foundation around which to orient some of its work."

4.2 This recommendation was acted upon, and in November 1945 the R and F Divisions were consolidated into the Physics Division with John H. Manley as Division Leader. The only group which was not absorbed was the Super and General Theory Group (Group F-1) under Edward Teller. This group was transferred to the Theoretical Division on November 14, 1945 (Chapter III). These changes resulted in the following organization at the end of 1945:

P-2	Water Boiler	L. D. P. King
P-3	Cockcroft-Walton accelerator	H. H. Barschall
P-4	T-Reaction	E. Bretscher and H. Staub
P-5	Reactor	P. Morrison
P-6	Van de Graaff Research	R. Taschek
P-7	Cyclotron	R. R. Wilson

P-8 Radioactivity  
P-10 Fission Studies

R. Segrè  
H. L. Anderson

4.3 The Division was rounded out during 1946 by the addition of other groups: P-1, Electronics under Wilbur Hane, (formerly Group G-4 in the old G-Division) was absorbed in P-Division January 1, 1946; Group P-3, Cockcroft-Walton accelerator, or D-D source, remained under Barschall until July 1946. Jorgenson became Group Leader and continued in this position until the group was consolidated with Group P-6 in September 1946. The combined group retained the designation P-3, under Richard Taschek, and continued work on both the Van de Graaff (short tank) and the Cockcroft-Walton accelerator. P-9, Van de Graaff construction under J. L. McKibben, was a new group formed in January 1946 with the responsibility of completing a new Van de Graaff; the latter part of January 1946, P-13, Cosmic Rays Group, was formed under Darol Froman. This section was devoted to research on atmospheric radiations, particularly the neutron component.

4.4 A further reorganization took place in February 1946. Groups P-7, P-8, and P-10 were discontinued and a rearrangement of designations and responsibilities followed, leaving the following division structure which remained (although with some changes in group leaders) throughout 1946:

P-1 Electronics	Ernest Titterton
P-2 Water Boiler	L. D. P. King
P-3 Van de Graaff (short tank) Cockcroft-Walton accelerator (formerly P-6)	Richard Taschek
P-5 Fast Reactor	David B. Hall
P-9 Van de Graaff construction	J. L. McKibben
P-11 Betatron	William Ogle
P-12 Cyclotron	J. A. Fowler
P-13 Cosmic Rays	Darol Froman (Group dissolved June 1946)

4.5 Dr. Manley resigned his position as Division Leader in July in order to do further research work and Dr. J. M. B. Kellogg became Division Leader. Dr. Manley remained in the division as Associate Division Leader.

### Physics Division Activities

4.6 The main efforts of the division were centered around problems of the fission process, the D-D and D-T reactions, the scattering process, and the fast reactor.

## THE FAST REACTOR

4.7 In the fall of 1945, Dr. Phillip Morrison suggested the construction of a new nuclear reactor at Los Alamos. This was the first to be undertaken in the Manhattan District since the close of the war, and it was to be different in principle from all other existing reactors.

4.8 It was specifically proposed that the Laboratory build a reactor utilizing plutonium and operating on fast neutrons at a power level of about 10 kw with mercury as a coolant. The philosophy underlying this proposal was based on the following assumptions:

- (a) The Laboratory needed more information on the properties of near-critical systems operating on fast neutrons since the bomb itself was a supercritical system based on fast neutrons.
- (b) The spectrum of fast neutrons produced by such a reactor would be closely the same as that from the bomb itself, and the reactor would thus form a useful tool for the exploration of problems associated with nuclear reactions in weapons.
- (c) No plutonium reactor and no fast reactor had yet been attempted in spite of the fact that such systems were potentially of great interest both from the point of view of the production of useful power and from the point of view of breeding or conversion of fissionable materials.
- (d) The desirability of such an objective, having both weapon goals, and yet application to the peaceful uses of atomic power, was apparent in a laboratory striving to establish itself on a useful and effective postwar plane.

4.9 Approval was granted by Major General L. R. Groves for this construction and the necessary plutonium allotted from material on hand of a character not completely satisfactory for weapon use.

4.10 Ground was broken for the new laboratory building in Los Alamos Canyon (adjacent to the Omega Laboratory housing the Water Boiler) on May 15, 1946. This building was the first on the mesa to be planned on the basis of permanent construction.

4.11 Experiments on rods of the active material began in March 1946 under R. D. Baker's Group, CMR-5 (6.23). The extrusion of Pu  $\delta$ -phase rod at low temperature led to partial transformation to  $\alpha$ -phase, presumably induced by the great amount of working. High-temperature extrusion, all in the  $\delta$ -phase stable region, proved unsatisfactory from the point of dimensions but the density remained low. Machining of extruded oversize rods, in this manner, was undertaken in April and was successful enough to start production

in June.

4.12 The canning process was also begun in June. One rod was experimentally canned in a special air-filled disposable can. This was exposed in high flux in the Water Boiler. The complete operation was moved to DP Site for general health reasons the latter part of the year.

4.13 Dr. Morrison accepted a position at Cornell University, and Dr. David B. Hall continued as leader of this work.

4.14 Final assembly of the reactor progressed rapidly during the summer of 1946. By August the tamper blocks of uranium had been plated with the adopted 3-mil electroplated Ag and were assembled. The active material had been introduced into the reactor can and the tamper closed by use of the safety block and installed hoist. This operation was performed by remote control.

4.15 Initial critical assemblies of the fast reactor were started on September 12 and continued for three days until mechanical failure of the bottom tamper mechanism resulted in a suspension of operations for almost 60 days while the apparatus was taken down and completely reassembled. Some of the associated reactor equipment was redesigned at this same time with particular emphasis on the safety block mechanism.

4.16 Early in November, the reassembly of the reactor had been completed including the aluminum envelope enclosing the reactor pot, uranium tamper, tamper cooling jacket, steel tamper, and 4 inches of lead shielding. Considerable progress also had been made on the electromagnetic mercury pump, the mercury flowmeter, heat exchanger, and supply and sump tanks, but this auxiliary equipment was not completely finished.

4.17 Critical assembly measurements were again started on November 19 (without coolant or the external radiation shield), and critical conditions were reached two days later.

4.18 The following table gives the loading and observed multiplication when all tamper materials (safety block, top tamper, control and safety rods) were in position of maximum reactivity. The reactor cage had available 55 holes for insertion of active material rods. The plutonium was loaded in a central array and all remaining holes filled with rods of natural uranium. These first assemblies were done without mercury in the reactor pot.

<u>No. of plutonium rods loaded</u>	<u>M<sub>obs</sub></u>	<u>1/M<sub>obs</sub></u>
10	2.20	0.455
15	3.91	0.256
17	5.41	0.185
19	8.55	0.117
21	14.8	0.068
22	23.1	0.043
23	48.5	0.021
24*	∞ (critical)	0

\*The critical mass was 23.8 rods as estimated from the control rod calibration. The critical condition was found by bringing the pile to a slow period by means of a control rod.

#### THE ELECTRONICS GROUP

4.19 P-1, with Ernest Titterton, Group Leader, functioned efficiently as a service unit of the division. Efforts were not solely confined to P-Division, but were extended to all technical groups. This was particularly true during the summer of 1946 when loss of trained electronic men in the technical groups threw an extra burden of repair work and designing on Group P-1. Besides the above routine duties, the group completed and tested engineering models of oscillators, gauges, analyzers, and amplifiers.

4.20 Certain technical problems arose in October 1946 which received priority from the Electronics Group for the rest of the year. The most important of these research matters was cyclotron arc modulation. It was necessary to redesign frequency dividers and modify certain other features of McDaniel's circuits (4.61). Research was initiated on a degenerative stabilizer circuit for the D-D source to prevent the beam from wandering off the target. A third objective was research on McKibben's informer problem on the 8 Mev Generator (4.41 ff). The fourth major item confronting the group was an order for heavy duty power supply and control circuits for pulsing a spark gap light source in synchronism with a fast camera. There were serious difficulties in connection with extinguishing the spark at frequencies as high as 1500 cps, and it was estimated that it would require three months to solve the problem.



## THE WATER BOILER

4.21 The Water Boiler Group, P-2 (formerly F-2), under L. D. P. King, successfully operated the "boiler" for 3783 kwh during the period August 1945 to December 20, 1946, for a total of 4809 kwh. During this period, research work continued and changes were made towards making the Water Boiler a permanent research tool.

4.22 During July 1945, the reactivity of the pile greatly decreased owing to the excessive loss of nitrogen and the formation of a precipitate. To avoid future trouble of this type, some minor design changes were made before re-assembly, and the nitrogen concentration was maintained at a normal level. This required the addition of acid and water in the ratio of 1.4 to 1 instead of the previous value 2.8 to 1

4.23 The over-all radiation in the building was substantially decreased by improving the shielding in the gas outlet line, thermal column, and ports. The controls were completely rewired. The safety circuits were simplified and the installation of a new large fission chamber in April permitted a linear calibration of the automatic control over the entire operating range. The accuracy of this control was increased by incorporating a complete commercial potentiometer in the balancing circuit.

4.24 An analysis of the gas from the boiler indicated that about 30 per cent of the total fission activity is carried off in this manner. An intensity of 40 r/hour at 1 foot from the outlet line is observed during full power operation. The gas evolution due to electrolysis was found to be about 2.3 cc/sec/kw. Considerable difficulty was experienced with background activity from the radioactive gas. On several occasions it was even necessary to stop boiler operation for health hazard reasons. Plans were begun to obtain a permanent solution for this problem. A shielded concrete pit was constructed to house the safety liquid trap for the gas outlet, and the outlet line in the vicinity of Omega was all made of stainless steel pipe buried underground. The gas outlet was removed to a wider part of South Mesa, about 1500 feet from Omega. The gas was released from a point about 60 feet above ground. Indications in December were that the gas backgrounds were improved but not yet solved. A high stack and gas dilution might be more satisfactory.

4.25 Numerous irradiation of samples continued throughout 1946 for other groups, notably for the health group, radiochemistry group and other groups in P Division.

4.26 Research work was continued along several lines. Experiments on short delayed neutrons and gamma rays from  $U^{235}$  and plutonium were

continued. A long series of measurements was begun on the ranges and fission yields of plutonium fragments; the heavy group has essentially been completed and work on the light group has begun. The cross sections of  $^{40}\text{-h La}^{140}$ ,  $\text{I}^{129}$  and  $\text{Sm}^{28}$  were determined. Construction work on a thin lens beta ray spectrometer for energies up to 15 Mev was completed in July 1946. A preliminary run with  $\text{Ta}^{182}$  indicated poor resolution. Collimating slits, however, had not been adjusted and no current stabilizer was used on the generator. A large 30 inch diameter fission chamber was begun for measuring angular distribution in scattered neutrons. The chamber consists of 15 one-inch concentric rings coated with  $\text{U}^{235}$ .

## PARTICLE ACCELERATORS

4.27 At the close of the war, the Los Alamos Laboratory found itself with a variety of equipment which had been borrowed or leased from various institutions. Chief among this equipment were the following accelerators:

The 40 inch Harvard Cyclotron

The University of Illinois Cockcroft-Walton accelerator

The University of Wisconsin "Short Tank" Van de Graaff

The University of Wisconsin "Long Tank" Van de Graaff

4.28 While Los Alamos recognized the need and desire of the owners of this equipment to repossess it in order that nuclear research might be recommenced in academic laboratories, nevertheless, the Laboratory was understandably reluctant to lose this equipment as its long program of reconstruction began. The health of the Laboratory at this time demanded that active research be pushed with as much enthusiasm as possible, and the ability of the Laboratory to proceed with an immediate research program was one of its few attractions. Accordingly, efforts were initiated to purchase outright as much of this equipment as the individual universities might be willing to sell. In some respects, there was found more enthusiasm for these proposals than might have been anticipated. The rapid advances of the war years had filled all physicists with a desire for bigger and better accelerators - and the prospect of disposing of older and smaller equipment at a reasonable price and using the proceeds to finance larger-scale devices turned out to be rather attractive.

4.29 Ultimately arrangements were completed to purchase all of the above equipment, with the exception of the University of Wisconsin "long tank" Van de Graaff accelerator. The success of this program cannot be underestimated in providing the Laboratory with efficient tools for research at a time when it desperately needed such attractions. It is dubious if it

would have been possible to maintain an operating division in nuclear physics had a long program of accelerator construction been required, and the cooperation of the above universities in being willing to sell their equipment indicated a real willingness to assist the Laboratory.

## Cockcroft-Walton Accelerator and Short Tank

### COCKCROFT-WALTON ACCELERATOR

4.30 Experimentation by this group was greatly curtailed by the water shortage the latter part of 1945. The D-D source could not be operated; DP Site suspended operations and could not deliver source; and work on ion sources ceased.

4.31 By the end of February 1946, the water supply became more abundant and experiments with the accelerator, ion sources, disk scattering, measurements of D-D cross sections, and scattering of high-energy neutrons by H and D again went forward.

4.32 In March 1946, the results of measurements for D-D neutrons were obtained. The scattering of neutrons by hydrogen still showed a slight (<5 per cent) preference for the backward scattering of neutrons.

4.33 The scattering of D-D neutrons by deuterons showed a strong anisotropy. In the center-of-mass system the differential scattering cross section per unit solid angle is 2.2 times greater for neutrons scattered through  $180^\circ$  than for neutrons scattered through  $90^\circ$ . The area under this peak in the differential scattering cross section is about 15 per cent of the total cross section.

4.34 Tests were made throughout April and May to establish the fact that the yield of neutrons and protons from the D-D reaction is constant for a given set of conditions. Discrepancies were traced to a too low pumping speed at the target chamber. In June, a by-passing pumping lead and smaller diaphragms to restrict the beam were installed. This decreased the variations of yield somewhat but not completely.

4.35 The Cockcroft-Walton accelerator group continued runs on D-D yields after the Van de Graaff was changed over to the tritium program. The main reason for the variation of data seemed to be unstable operating conditions of high voltage output. An electronic stabilizer of high voltage was installed, but experimentation was still in process as of the end of 1946, and evidence was not conclusive that the trouble had been entirely eliminated.

4.36 As previously stated (4.3) the Cockcroft-Walton Group was an independent unit of the Physics Division (P-3) until September 1946 when it was combined with the short tank group inasmuch as their experiments were often the same except on the different types of accelerator.

#### SHORT TANK VAN DE GRAAFF

4.37 This group's activities were completely halted by the lack of water during the winter of 1945, and not until early spring 1946 did their work continue.

4.38 By March 1946, the group had completed evaluation and analysis of measurements on saturation behavior and the characteristics of the Frisch grid.

4.39 The program for the short tank changed in August 1946 when various aspects of the tritium source were placed under observation. Assembly and construction of the D-T experiments called for modifications of the tank. The diffusion pump was set up with silicone oil. All graphite and carbon shutters, liners, slits, and diaphragms were replaced with tantalum. A glass-uranium pumping system was installed with forepumps sealed; safety circuits were made with large burettes for the fore pumps to permit the tritium to go to the forepumps in case of a double accident.

4.40 A tritium sample of rated 18 per cent concentration was admitted to the U pump on November 29, 1946. The data resulting from bombardments indicated that the sample was weak, probably not containing more than 5 per cent of T. Before further experimentation could go on, it was necessary to get a richer sample for target material.

#### VAN DE GRAAFF CONSTRUCTION

4.41 The loss of the "Long Tank," however, placed a serious gap in the range of neutron energies which the Laboratory could investigate, and introduced this gap in those experiments devoted to the utilization of thermonuclear reactions. As such long range problems were considered to be fundamental to the philosophy of the Laboratory (Appendix No. 1), the problem of remedying the situation was considered.

4.42 Since a new machine had to be constructed, and inasmuch as no adequate accelerators were planned for construction by any of the major electrical companies, the Laboratory was able to consider the most desirable type

for its purposes. After some preliminary and small scale experimentation, it was decided that a Van de Graaff accelerator in the range of 8 to 12 million volts would permit the entire energy spectrum of neutrons from the lowest energies up to more than 20 Mev to be investigated. The cost of such an instrument was estimated at \$500,000 and, if constructed, and successful, would be the largest generator of its kind in the world. Permission was requested of General Groves to embark upon this program, and this was granted on December 12, 1946.

4.43 The responsibility for the design of the machine was carried out by Dr. J. L. McKibben (Group Leader, P-9) with consulting advice of Dr. J. H. Williams of the University of Minnesota, Dr. R. G. Herb of the University of Wisconsin, and Drs. Van de Graaff and Trump of the Massachusetts Institute of Technology.

4.44 It was specifically proposed to use this accelerator in continuing the scattering and cross-section experiments, particularly with fundamental particles at higher voltages; to produce and study neutrons up to energies of approximately 25 Mev; to bridge the gap with experiments employing neutrons between 6 and 12 Mev, a range which could not formerly be reached with existing equipment; to study the  $N^{14}$ - $N^{14}$  reaction (important in connection with the possible ignition of the atmosphere); and to study new (p-n), (p-2n), and (p-d) reactions which may occur at these higher energies.

4.45 Almost as important as the above mentioned experimental field which this instrument offered was the opportunity it presented to attract and keep good nuclear physicists associated with the Los Alamos Laboratory. Particularly in the program of cooperation with universities, such a tool would be invaluable in maintaining a competent staff interested in basic nuclear physics and its potential application to military weapons.

4.46 Dr. J. L. McKibben outlined the proposed design and progress on the generator in a report dated October 11, 1946, to Dr. N. E. Bradbury. The proposed design consisted of a separation column permitting high pressures of special gases around the high potential electrode which could be operated without the charging belt in a high windage, corrosive atmosphere. This was to give flexibility to the machine, keep it freer from dirt, and make servicing simpler, since the critical parts were accessible by raising the vessel.

4.47 A small test generator using standard parts of the instrument under construction was constructed and in operation by July 1, 1946. It had a separation column  $1\frac{1}{2}$  feet tall by 1 foot in diameter. The high voltage electrode was charged with a 6-inch wide belt. The tank was 30 inches OD

and operated up to 500 psi. This was primarily to be a source of experimental information as well as a training mechanism for new personnel.

4.48 The plans for the large instrument took form as a divided pressure device with the belts running in a lower pressure region inside the separation column. Three evacuated tubes were to be provided in the low pressure region. Large shells located in the high pressure region outside the separation column served to divide the potential between the high potential head and the tank.

4.49 The insulating column or separation column was built up of a series of insulator "Mykroy" rings and steel rings. Mykroy, a lead-glass-bonded mica, has high compressive strength, good dimensional stability, high puncture voltage, and in addition is fireproof and malleable. It was selected for the purpose, therefore, over other possible plastics and phenolic bound paper.

4.50 In small-scale experiments under final conditions, voltage gradients of 1.5 million volts per foot were obtained.

4.51 Original plans called for a control room containing two laboratories, shielded with a concrete wall, and a small shop. The best design for the building seemed to be a steel tower 150 feet tall with a windbreak, with a 125-ton hoist located at the top of the tower for disassembly to accomplish internal repairs.

4.52 At the close of the year (1946), the generator tank design had reached the point where many orders were being considered by the manufacturers. The separation column had been ordered. The 256 steel rings were in process of manufacture by the Consolidated Steel Company. The die for making the Mykroy rings was completed in Los Angeles. A press had been loaned to Electronics Mechanics for the molding of these rings. The tank was being designed by the Consolidated Steel Company with an estimated five months' completion date.

4.53 Designs were not complete for the inner column or for the buildings, and the site location had not been finally approved.

#### THE BETATRON GROUP

4.54 P-11, under the supervision of S. H. Neddermeyer, became part of P-Division in January 1946, after M-Division ceased using the betatron for research (5.25).

4.55 Experiments were conducted throughout 1946 on photo fission

thresholds in normal uranium,  $U^{235}$ ,  $U^{238}$ , and plutonium. The most dependable results have come from the use of a shielded paraffin geometry about 5 feet from the betatron. These findings indicate that all fissionable material (such as plutonium, normal uranium, and  $U^{238}$ ) have thresholds at about 5.2 Mev. However, this work is not conclusive as it has been observed that the thresholds for the production of neutrons from the betatron is also 5.2 Mev. Therefore, there is a doubt as to whether the fission observed is neutron-produced fission or gamma fission.

4.56 An independent section of this group was devoted to work in chronotron and counter development. The chronotron is a system comprising a transmission line and a detector or an array of detectors coupled to the line at evenly spaced intervals, whose function is to determine the region of superposition for two transient pulses traveling along the line in opposite directions. The term "detector" is reserved for this specific meaning and the term "counter" is used to mean a device which produces a pulse when traversed by a charged particle. The ultimate purpose of the whole development was to produce a system of chronotron and counters by which velocities of charged particles can be measured by comparison with the propagation rate along the line.

4.57 The first chronotron model was completed in the summer of 1945. Tests with a single detector showed that, with pulses generated by a condenser discharge with amplitude 50 to 150 volts and time constant of the order of  $10^{-10}$  sec, time differences can be measured to an accuracy of about  $3 \times 10^{-11}$  sec.

4.58 A second model was finished in March 1946 and tests indicated a cleaner operation than with the old model, but the pulser gave serious difficulties. Experiments continued on this model until the last of June when Neddermeyer left for Washington State University. Shortly after his termination, this equipment was transferred to him at Seattle, Washington. The position of Group Leader of betatron activities was assumed by William Ogle on July 1, 1946.

### CYCLOTRON

4.59 After the reorganization of P-Division, the Cyclotron Group (P-12), under J. A. Fowler, had to reconstruct its own organization by indoctrinating an entire new crew, and by making certain repairs to the cyclotron.

4.60 Exploratory experiments were conducted on distribution of fission fragment energy as a function of incident neutron energy. A suitable fission

fragment energy counter was designed and constructed in March 1946. This problem was temporarily tabled in May 1946, to investigate the apparent fine structure of fission fragment energy spectrum, but was resumed the following month. Experiments were continued, but high radiation in the vicinity of the cyclotron caused considerable difficulty with the counter.

4.61 In October 1946, the Electronics Group started building circuits for modulating the arc of the cyclotron (4.20) with variable pulse widths. The detecting equipment was modulated in such a manner that the neutrons arising at the target due to the arc pulse were separated into energy groups by the time of flight over a fixed distance. Twelve successive time intervals (corresponding to twelve neutron energies) were employed. This equipment was still not completed as the year closed.

#### COSMIC RADIATION STUDIES

4.62 A temporary group under Dr. Darol Froman was set up in January 1946 to further scientific data on cosmic radiation (4.3). Four  $\text{BF}_3$  counters built for use at Operation Crossroads were adapted for measuring the neutron components of the cosmic rays. These counters had an efficiency of about 2 per cent for thermal neutrons.

4.63 A B-29 airplane from Z-Division was used for this work. The plane was modified by removing all gunnery equipment, armor glass, and hydrogenous material from the tail section, and installing the four counters: a bare (not shielded) enriched counter 3 feet from the other three, an enriched counter covered with 0.030-inch cadmium sheet, an enriched counter shielded with 1 inch of  $\text{B}_4\text{C}$  (normal boron - density 1.3 gm/cc), and a normal  $\text{BF}_3$  counter shielded with 1 inch of  $\text{B}_4\text{C}$ . These three counters were 2 feet from each other. The high-voltage box and preamps for these counters were also in the tail section. The filament supply and coaxial leads for the signals were strung from this section to the radar room, which contained the amplifiers, scalars, recorders, and power supply. A cadmium-paraffin-covered counter to monitor total neutron intensity was mounted in the radar room also.

4.64 Initially it was feared that the gasoline carried by the plane (some 6500 gallons) would affect the bare and Cd data. However, measurements taken at the same altitude at the start and end of a flight after the gas load had shrunk 3500 gallons were identical. Apparently then, the counters could be considered as being in free space.

4.65 It was thought that as altitude was gained counting effects from



showers might start, even with high bias settings. This was checked by running an enriched  $\text{BF}_3$  counter and a normal  $\text{BF}_3$  counter, bare and with a  $\text{B}_4\text{C}$  shield, at various altitudes, to discover whether there was a decrease or any other trend. Experiments indicated that the ratio stayed constant, which showed that the count was, at all times, either of neutrons or natural background.

4.66 Several flights were made before June 1946 when the group activities were dissolved. As a result of the first experiment, it was found that the Cd ratio remained constant at altitudes above 7,000 feet and has a value of 2.18. Also, the counting rates in all counters vary in the same way with altitude. Bad weather conditions and faulty mechanical performance during two flights curtailed the duration of the time aloft and good statistics were not obtained. One flight was attempted during cloudy weather, forcing the plane to remain below the main cloud body. Directly under the large cloud mass, the count was high except in the paraffin monitor. As the plane approached openings in the clouds, the count dropped.

4.67 Lack of personnel to staff adequately this group, and urgency of other experimental work in the Division, finally caused the program to be abandoned in June 1946. Full details of the operation were recorded by H. M. Agnew, W. C. Bright, and Darol Froman.

## Chapter V

### M-DIVISION

#### Formation of M-Division

5.1 In the reorganization of the Laboratory in the fall of 1945, M-Division was formed under Darol Froman, Division Leader, with the essential responsibilities previously assigned to the Weapon Physics Division or G-Division (Vol. I, Chapter XV). A chart is given below showing the various groups established in the new division and their relationship with groups in the previous organization:

M-1	Design and Production	R. E. Schreiber	In part G-Eng. and G-1
M-2	Critical Assemblies	L. Slotin	In part G-Eng. and G-1
M-3	Initiator	H. W. Fulbright	G-10
M-4	Electric Method	A. Graves	G-8
M-5	RaLa	D. Hall	G-6
M-6	Flash Photography	W. Koski	X-1C
M-7	Super Mechanics	J. Tuck	In part, G-2
M-8	Optics	B. Brixner	G-11
M-9	Magnetic Method	E. Creutz	G-3
M-10	Betatron	S. Neddermeyer	G-5
M-11	Consulting Engineering- Physics	J. T. Serduke	In part G-Eng. and G-10

Later, H. W. Fulbright returned to Princeton and D. P. McMillan took over M-3. Alvin Graves was group leader of M-4 until November 1, 1946, when he was appointed Associate Division Leader of M-Division. At this time Stanley Barris assumed the responsibilities of M-4.

## General Responsibilities

5.2 Conforming to a long-range policy of Laboratory activity, M-Division was assigned the following program of work including both peacetime applications of nuclear energy and a continuation of weapon development:

5.3 Maintenance of the Weapon Insofar as the Pit Was Concerned. This included engineering design, production, inspection and surveillance of all parts of the gadget inside the HE charge for the stockpiling of weapons. It also included the maintenance of field equipment, written instruction, and personnel with adequate knowledge and experience for assembly and tests. Of course, there was a considerable division of responsibility with the CMR Division in the production of active cores and initiators.

5.4 Critical Assemblies. This included not only routine measurements of the multiplication of fabricated cores, but also experimental work on problems of safing, on new models, and on spectral and intensity distributions of neutrons throughout the pit. Also there were rather extensive measurements to aid in the design of fast reactors, and miscellaneous measurements in connection with safety problems for the Los Alamos Project and other Manhattan District Projects.

5.5 Improvement on the Bomb. This experimental work included the induced motion and compression of parts of the pit by HE; the design and testing of new models; measurements of the improvement effected by new explosive arrangements; a detailed study of initiators; fundamental studies of shock waves and the associated hydrodynamics; some measurements on the effects of explosives in collaboration with X-Division.

5.6 Super Mechanics. This phase included experimental studies of proposed mechanical methods of initiating thermonuclear reactions.

5.7 Optical and Engineering-Physics Service. This responsibility embraced the design, procurement, etc., of special optical and photographic equipment and of physical measuring instruments for other groups and divisions as well as for M-Division.

5.8 In September 1946, M-1 was reorganized to take on, as part of its responsibilities, a program of weapons control, covering the pit in all its parts. The plan initiated was to transfer all completed pits, apart from the initiators and active material, to the stockpile at Sandia (8.13 ff). M-1 was to maintain surveillance, records, and stockpiling of the fabricated active material and the initiators. In the reorganization, La Roy Thompson became Acting Group Leader of M-1, and R. E. Schreiber took over Group M-2.

5.9 A committee consisting of M. G. Holloway, R. E. Schreiber, La Roy Thompson, and Wm. C. Bright, under the chairmanship of Bright, was appointed to advise M-1 on the preparation of manuals and kits for use by the Armed Forces at both storage and advance bases.

5.10 Another phase of the Design and Production Group was a training program for Army Officers, under the direction of M. G. Holloway. This training gave these men (chosen because of their excellent qualifications) a sufficient background in not only the necessary routine mechanical assembly operations but also in problems of safety so that they might intelligently cope with unpredictable occurrences or accidents. On November 1, 1946, William C. Bright assumed leadership of group M-1.

### CRITICAL ASSEMBLY

5.11 Critical assemblies of active material in various tampers was continued after the cessation of hostilities by the G-Division critical assembly group. Harry K. Daghljan, a staff member of this group, on the evening of August 21, 1945, performed the experiments but inadvertently obtained a super critical arrangement. He quickly dispersed the assembly, but in doing so received lethal exposure from radiation and neutrons. He died on September 15, 1945.

5.12 Louis Slotin's group, M-2, continued experimentation on composite cores, critical masses in various tampers, nuclear safety measurements, and work on the Fast Reactor (on a pro tem basis until Dr. Phillip Morrison returned to Los Alamos in April 1946 and his Group P-5 resumed operations (4.7).

5.13 Plans were laid in the fall of 1945 to transfer critical assembly work from Omega Site to Pajarito Site, and construction was started on a laboratory building. The new site was in operating condition by April 1946.

5.14 Most of the experiments conducted were as a service to other groups. For example, a number of measurements on critical masses of  $U^{235}$  biscuits in iron, in iron and uranium, and in iron and sodium tampers were made in April and May at the request of Dr. Walter Zinn of the Argonne Laboratory. It happened that in the measurement of the composite cores the fit of the tamper to the core was not always very good. There were cases in which the cavity was known to leave a gap of definite size around the active core. Qualitatively, it was found that a small gap reduced the observed multiplication by quite a large factor.

5.15 An experiment with a critical assembly on May 21, 1946, resulted

in another serious radiation accident which caused the death of the Group Leader, Louis Slotin, nine days later. This occurrence practically halted all work in critical assemblies. The Laboratory devoted serious thought to a means of continuing this essential work without danger to those involved. It was apparent that such studies were essential to the progress of the Laboratory, were also required in the course of weapon production work, and were expected of the Laboratory by many other parts of the Manhattan District. While it was clear that no machine could think as well as a trained man, it was also clear that a machine could do what it was prescribed to do and could be provided with a variety of automatic controls and safeguards.

5.16 Inasmuch as it was clear that this work would cease unless something drastic was done, the Laboratory decided to forbid (they had been stopped anyway) all manual critical assemblies; to provide a critical assembly laboratory operated by remote control and provided with every practical safety device that could be devised; and to locate such a laboratory at a distance from the control room and separated from it by earth embankments. Then should an accident occur, there would be the protection of both inverse square law and absorption. Finally, all critical assembly experiments were made subject to certain procedures and required both the presence of specific individuals and detailed prior approval at high levels.

5.17 After much deliberation, it was decided to construct an assembly and instrument building in Pajarito Canyon about 1250 feet from the main laboratory, which was to become a control room. The instrument room was thoroughly shielded from the assembly room. Photographs were to be taken of the assemblies through periscopes; television and telephoto equipment also were to be incorporated. Special remote control equipment was designed and constructed. One such piece called "Topsy" ("I just grewed" from Uncle Tom's Cabin) was to stack various cubes of  $U_{235}$  into an assembly by remote control. At the end of 1946, approximately 60 per cent of all construction and installation of equipment had been completed.

5.18 After the death of Dr. Slotin, R. E. Schreiber became Group Leader and M-2 performed experiments on storage safety problems and weapons measurements, while critical assembly work was suspended. The group also prepared the Pajarito Safety Manual for use of all personnel in M-2.

5.19 A new guarding system at Pajarito was initiated in December 1946, with the following three phases:

Plan 1 was the normal operating condition with no active material present, and involved no special restrictions on persons entering and leaving the area.

Plan 2 went into effect when active material was present but no experiments were in progress. Access to the laboratory was only by means of an exchange badge.

Plan 3 went into effect when an experiment with active material was in progress. Access to the area was then controlled by the person in charge of the experiment. Everyone entering at such a time was to have a film badge.

### SPECIAL PHOTOGRAPHY

5.20 The Photographic and Optics Group continued its role as a service group as well as an experimental group.

5.21 Preparation for the Crossroads tests began the latter part of 1945 for this section. All cameras and photographic equipment had to be thoroughly tested before shipment to destination. Supplies were stockpiled for the tests, and Kardex files were set up for all equipment involved. Special studies were carried out to determine the variation of image size as a function of density for the purpose of obtaining corrected measurements of the expanding ball of fire. Preliminary studies were also made on methods of calibrating effective focal lengths of lenses. Part of the group was sent to Bikini to construct camera installations and to act in advisory capacities.

5.22 After Able and Baker Tests, the group was deluged with the work of correlating the photographic results. All the equipment returned had to be cataloged, cleaned, and repaired. Some movie and still film had to be processed. Great quantities of photographs required sorting and filing with proper explanatory data. The group edited two complete films: one (16 mm) showing the activities of Los Alamos in the Crossroads Operation; the other (35 mm) showing the two explosions.

5.23 Besides the additional work brought about by the Bikini tests, the Photographic Group prepared various reports supported by photographs and graphs. One, completed April 2, 1946, was the Time-Space Relationships by Julian Mack. Another report, completed December 10, 1945, was by Donald C. Livingston on Gamma Radiation at Hiroshima.

5.24 The group also studied airborne camera installations for combat use at Sandia Base.

5.25 Four of the groups in M-Division organization (5.1) were ultimately discontinued either because their purpose no longer existed, or because their function could be achieved more efficiently by another group or division.

The Super Mechanics Group, M-7, was devoted largely to the Cross-roads tests and was finally discontinued entirely in February 1946.

The Magnetic Method Group, M-9, was dissolved January 1, 1946. The Magnetic Method (Vol. I, 15.18) was discarded at that time except as an auxiliary in the RaLa methods.

The Betatron Group. On January 1, 1946, it was also decided not to use the betatron, Group M-10, in the immediate future for the study of implosion (Vol. I, 15.23), but to retain all facilities at K Site so that work could be resumed on short notice. This group was transferred to P Division (4.54) so the accelerator could be used in physics experiments.

The Consulting Engineer Physics Group, M-11, was apportioned to M-6 and to the CMR Division. The group became entirely inactive November 1, 1946.

## Chapter VI

### CHEMISTRY AND METALLURGY RESEARCH DIVISION

#### Division Organization

6.1 Late in October 1945, the Chemistry Metallurgy Division became CMR Division under Eric R. Jette, who assumed the position of Division Leader when the co-division leaders, Joseph Kennedy and C. Smith, left the project.

6.2 A period of evolution followed. CM-1, the Service Group, dissolved about this same time and the designation was not reassigned until December 1, 1945. Then CMR-1, Analytical Chemistry (formerly CM-9), under H. A. Potratz, and CMR-3, Polonium Chemistry, with D. S. Martin, Group Leader, were added to the Division. The organization at the end of 1945 was quite different in structure and personnel from the one established in August 1945 (Vol. I, Chapter XVII), and is listed herewith:

CMR-1	Analytical Chemistry	H. A. Potratz
CMR-2	Chemical Research and Development	C. S. Garner
CMR-3	Polonium Chemistry	D. S. Martin
CMR-4	Radiochemistry	G. F. Friedlander
CMR-5	Heat Treatment and Metallography	G. L. Kehl
CMR-6	Metal Fabrication	J. M. Taub
CMR-7	Corrosion Protection	D. Lipkin
CMR-8	Metal Production	R. D. Baker
CMR-9	Metal Physics	E. F. Hammel
CMR-10	U <sup>235</sup> Chemistry	K. M. Harmon
CMR-11	Pu Production	J. E. Burke
CMR-12	Health Instruments	W. H. Hinch



6.3 In February 1946, Group CMR-10 was dissolved and functions transferred to CMR-8 under R. D. Baker, and in July 1946, CMR-7 was discontinued.

6.4 A new Group, CMR-13, Process Development, under R. B. Duffield, was established March 1, 1946, to develop a new plutonium purification procedure for DP Site. After fulfilling its mission, the group was dissolved in July 1946 and all personnel were transferred to CMR-11 at DP Site.

6.5 Further slight changes in redesignations of certain groups as well as changes of group leaders left the following organization in existence at the end of 1946.

CMR-1	Analytical Chemistry	Charles F. Metz
CMR-2	Chemical Research and Development	J. F. Lemons
CMR-3	Initiator Chemistry	D. I. Vier
CMR-4	Radiochemistry	R. W. Spence
CMR-5	Physical Metallurgy	F. M. Walters, Jr.
CMR-6	Metal Fabrication	J. M. Taub
CMR-8	Metal Production	R. D. Baker
CMR-9	Metal Physics	E. F. Hammel, Jr.
CMR-11	Pu Production	Frank K. Pittman
CMR-12	Health Instruments	James Tribby

### General Policy of CMR Research

6.6 Chemical and Metallurgical research for the Los Alamos Project dealt with problems of all fissionable materials (with slight attention to uranium). It also dealt with radioactive materials of high radioactivity, especially with problems where the use of considerable quantities of such materials was either desirable or necessary; in other words, problems which could not adequately be handled on micro- or milligram scale.

6.7 This policy was primarily based on the following:

- (a) The division was mainly concerned with the production, isolation, and utilization of large quantities of fissionable or radioactive materials. Results of very small scale investigations had, in the past, proved unsatisfactory for the purpose of the Laboratory.
- (b) The protection of the men working on the larger amounts of such materials necessarily required elaborate equipment, special techniques, medical inspection, and auxiliary service

which Los Alamos had developed to a high degree during the early years of Laboratory operation. The health hazards involved in working with large quantities, whether expressed in mass or radiation energy, cannot be appreciated by inexperienced persons. Another grave danger existing where the scale of operations is large was the possibility of contaminating the surrounding community from the laboratories. Here again Los Alamos was experienced in providing protective measures.

### SPECIFIC DIVISION PROGRAM

6.8 Early in the spring of 1946, Jette outlined the various phases of work which faced his division:

- (a) Metallurgical and Physical Problems
  - (1) Studies in the physical and mechanical properties of plutonium, other transuranic elements as they became available, and polonium.
  - (2) Phase diagrams of plutonium and other transuranics and their alloys.
  - (3) Studies of alloys including transformation rates and mechanisms, and precipitation hardening.
  - (4) Development of methods of fabricating plutonium and its alloys.
  - (5) Corrosion rates and methods of retardation.
  - (6) Diffusion rates involving plutonium, uranium, polonium.
- (b) Plutonium Chemistry
  - (1) Preparation of the metal
  - (2) Dry Chemistry
  - (3) Wet Chemistry
- (c) Polonium Chemistry
- (d) Tritium Research
- (e) Effects of Intense Radiation
- (f) Research on Transuranics
- (g) Classical Radio Chemistry
- (h) Research in Analytical Chemistry. Much work is required in this field. Usually specific problems have to be solved which are not of great interest outside this project. Methods for

plutonium and uranium analysis include spectroscopic, fluorimetric, polarigraphic, etc.

- (i) Miscellaneous Chemical Problems. This included the study of the solubility of various metals in mercury; and the preparation of anhydrous halides of various metals.

## Chemistry Activities

### ANALYTICAL

6.9 The leadership of Group CMR-1 changed twice from August 1945 to March 1946. H. A. Potratz remained Group Leader until January 1946, when he was succeeded by L. P. Pepkowitz. Pepkowitz, in turn, was followed by C. F. Metz in March 1946.

6.10 Analytical research for CMR practically came to a standstill the latter part of 1945. The only work which was carried on was the routine analysis having to do with production. This quiescence continued even until spring of 1946, when Group CMR-1 reflected the new interest born in the Laboratory.

6.11 Since that time routine analysis has progressed, analytical procedures have been refined and standardized, and research has gone well forward. Investigation has followed these general courses: (a) Research on the improvement of existing analytical methods; (b) Research for the development of new analytical procedures necessary to solve new problems. An example of this was the investigation to determine alloying constituents in both plutonium and uranium, and procedures for determining the plutonium and uranium content of waste solutions. In this connection the group worked closely with CMR-8 in the analytical work on the recovery and purification of  $U^{235}$  (par. 6.28ff).

6.12 From this generalization, it is evident that CMR-1 entered practically every phase of new and old experimentation, not only for the CMR Division, but as a service group for other divisions.

### CHEMICAL RESEARCH AND DEVELOPMENT

6.13 Group CMR-2 was another service unit of the division performing

routine radioassays for plutonium and maintaining the electronic equipment for radioassays. Certain phases of research were carried on in solubility determinations for plutonium compounds, oxidation and reduction of plutonium.

6.14 C. S. Garner supervised the group until February 1946 when K. M. Harmon was appointed group leader. Harmon remained in this position until June 1946 when he was succeeded by J. F. Lemons as acting group leader.

6.15 During August 1945, the group began to devote an increased amount of time and personnel to finding a satisfactory chemical method for separating lanthanum from barium for the RaLa program. This action seemed justifiable from the number of promising leads uncovered in exploratory work.

6.16 Investigation was continued through the end of 1946 on the deposition of RaLa on insoluble fluorides. This was based on a method studied by CMR-4 which involved the use of  $\text{CaF}_2$  as the insoluble fluoride. This work consisted of a search for other relatively insoluble compounds which have the proper solubility relation to  $\text{LaF}_3$  to give (a) more complete recovery of the lanthanum compound in the new form, (b) more rapid conversion, and (c) satisfactory filtration properties.

#### INITIATOR CHEMISTRY

6.17 The process of producing initiators by group CMR-3 (under D. S. Martin until August 1946, when D. I. Vier became Group Leader) had been planned for DP East Site. However, construction and installation of the highly technical equipment consumed much more time than had been anticipated, and it was not until September 1945 that production started in the new laboratory. The process was always of the highest difficulty, and involved the use of a material as hazardous as plutonium.

#### RADIOCHEMISTRY

6.18 Group CMR-4 (R. W. Spence, Group Leader) continued its program on radiolanthanum (RaLa) development and operations, Water Boiler chemistry, and tritium experiments (Vol. I, 17.31).

6.19 No change was made in the RaLa method (Vol. I, 17.41 ff) which had proved satisfactory up to 2000 curies. However, refinements of operation (including a new source container) and the introduction of new flow sheet,

specifying and simplifying operations, made it possible for personnel to handle up to 3000 curies, but the dosage was somewhat too high for continued operation at these levels. At the same time this redesigning of operations speeded up the extraction of the active material.

6.20 Work on the uranyl salt solution, "soup," for the Water Boiler continued under this group, involving the routine procedure of analyzing and purifying the gases evolved (4.21).

6.21 As early as May 1946, the group prepared a foil of tritium in the form of water THO (half the hydrogen as the tritium isotope) absorbed on the surface of freshly prepared aluminum oxide,  $\text{Al}_2\text{O}_3$ . Preparations were underway in the summer of 1946 for further experiments to determine the half life of tritium, and to investigate the magnetic moment of the triton.

## Metallurgical Developments

### PHYSICAL METALLURGY

6.22 CMR-5 was under the supervision of G. L. Kehl until February 1946 when R. D. Baker became acting group leader in addition to his responsibilities as group leader of CMR-8. Baker remained in that status until August 1, 1946, when F. M. Walters, Jr., assumed group leadership in addition to his duties as associate division leader.

6.23 The problem of developing methods of fabrication for the fast reactor rods was included in the group agenda early in March 1946 (4.11). Extrusion methods proved most suitable, but although correct density was obtained, for some obscure reason the extruded bars were slightly tapered. The ultimate solution of this problem lay in fabricating the rods 0.02 inch oversize, and machining them by a special method until they met specifications. It was found that the bars could be machined to 0.0005 inch in diameter over a 6 inch length. Plans were made in June to transfer the manufacture of these rods to DP Site to eliminate as much serious contamination as possible. By July, five extrusions had been made, four of which met specifications and were sent to DP for machining and coating.

### METAL FABRICATION

6.24 The Metal Fabrication Group had been designated CM-7, supervised by J. M. Taub, until December 1945, when it was renumbered CMR-6.

However, there were no changes either in the group functions or in its leadership. The group carried on an extremely varied program of work, not only for CMR Division, but for the other technical divisions. Its routine services included refractories, general foundry work with uranium and special alloys, plastic services, electroplating, and general powder metallurgy.

6.25 Besides these functions of CMR-6, they also conducted research on problems peculiar to their work. As a result of the investigations a new process of fabricating uranium spheres was completed in July 1946. This new set of specifications involved new vacuum casting furnaces and new machining jigs. The process made it possible to make two or possibly three castings per day instead of the one casting formerly obtained.

6.26 Production of special pieces for the fast reactor assembly (4.7) was completed in June 1946. Development on the generating tower for the Van de Graaff construction (4.41) included work on the Mykroy rings and shellac adhesives. This fabrication on the Van de Graaff was started in April and was still underway at the end of 1946.

6.27 Another interesting phase of work was the recovery of normal uranium metal from the shop turnings. Vacuum casting the material, where the charge varied from 100 per cent down to 50 per cent briquetted turnings with the remainder good uranium metal, yielded a metal recovery of only 50 per cent. In August 1946, a different method was begun consisting of melting in air under a barium chloride flux and then bottom-pouring into a graphite mold, and yielded recoveries up to 65 per cent when one-third of the charge consisted of virgin metal. When Ames biscuit metal was used as the virgin metal, the metal recovery increased to 77 per cent on the turnings, with 100 per cent recovery on the virgin metal assumed. A program of remelting the uranium turnings (approximately 7,000 pounds were on hand) was begun in October. With the equipment available at that time it was possible for one man to process 60 pounds of turnings per day. Larger briquetting dies were in process which would increase this output at least three times.

## METAL PRODUCTION

6.28 The methods for the recovery and purification of  $U^{235}$  at the end of 1945 were not well worked out and were quite unsatisfactory from the standpoint of efficiency and safety.

6.29 Group CMR-8, under the supervision of R. D. Baker, carried the production load as well as conducted research in the field. In fact, CMR-8

continued to produce all the  $U^{235}$  metal for the Manhattan Engineer District. However, it was not possible for the group to conduct an intensified program of investigation until it had absorbed the personnel from CMR-10 in February 1946 (6.3). After that time, work was started to develop processes for the recovery of  $U^{235}$  from all residues originating at this project.

6.30 A more efficient and less hazardous hydrofluorination process for the conversion of purified oxide to the tetrafluoride was developed and put into operation. The use of this process made it possible to start putting considerable quantities of  $U^{235}$  back into circulation.

6.31 Late in 1946 all the installations in D and M Buildings used by this group were overhauled to reduce the contamination danger. Dry boxes and equipment for enclosing the reduction operations on  $U^{235}$  were installed.

### METAL PHYSICS

6.32 Group CMR-9, Metal Physics (E. F. Hammel, Group Leader), established the following program of experiments early in 1946:

- (a) Specific heat of plutonium from room temperature to the melting point.
- (b) Thermal conductivity of plutonium at room temperature.
- (c) Self-diffusion studies on uranium.

6.33 A portion of D-building was set aside for these investigations, and furnace and control apparatus, a constant-temperature bath, a vacuum system and auxiliary parts were designed. Construction and installation of this equipment expended most of the efforts of this group for the remainder of 1946.

6.34 A preliminary value was obtained, in July 1946, for the thermal conductivity of delta-phase plutonium. During the last quarter of 1946 this was investigated further. These tests were conducted at six different temperatures in the  $0^{\circ}$  to  $60^{\circ}\text{C}$  range. The value of the thermal conductivity of plutonium was found to be  $0.0195 \pm 0.0005$  gram-calories per square centimeter per second for a temperature gradient of  $1^{\circ}\text{C}$  per centimeter in the temperature range mentioned.

### Plutonium Production

6.35 Plutonium production was charged to Group CMR-11 and, as shown

on the organization chart for December 1945, J. E. Burke was the group leader. He remained in charge until March 13, 1946, when S. J. Cromer took his place. Another administrative change occurred in November 1946, when Cromer left and F. K. Pittman became group leader.

6.36 DP Site, which was to be the new production area, was divided into the East Area for the processing of polonium (6.17), and the West Area for the processing of plutonium and the production of bomb cores. (The details of design and building are covered in Vol. I, Chapter XVII.) Construction of the site was largely completed by the middle of August 1945, but it was actually a month later before all the hoods and technical equipment were installed and operations could begin.

6.37 Conspicuous among the Laboratory worries on plutonium production was the process used in the purification of the plutonium nitrate slurries received from Hanford, and the conversion of these slurries into metal. The established processing technique at the close of the war involved an ether extraction of plutonium nitrate in glass columns. This was the process used when DP Site became the center of operations. The fragility of the glass columns, the explosive nature of the ether vapor, and the toxic properties of the plutonium combined to make DP Site a potentially extremely hazardous installation.

6.38 As previously mentioned (6.4) a new group, CMR-13, came into being in March 1946 with the responsibility of aiding in the development of a new plutonium purification procedure. This group worked harmoniously with CMR-11, the Plutonium Production Group, on this mutual problem.

6.39 For some time previous, research on alternate processes of purification and reduction had been under consideration and experiment. And in June 1946 a process involving a simple oxalate precipitation, with the consequent entire elimination of the ether stage, was developed and incorporated in the production cycle.

6.40 This conversion to the new process not only increased the safety of the operation, but the resulting product was equal in quality to that produced by the earlier method. As a result of this and other engineering and process developments, the backlog of plutonium material from Hanford was consumed and converted to metal.

6.41 In the fall of 1946, a new engineering and development section was formed in CMR-5 under Frank Pittman. Its main tasks were to improve existing operations further, especially in the redesign of plant equipment, and to make working conditions less hazardous. Additional research problems under its jurisdiction included new methods for the recovery of reduction and



casting residues, supernatant solutions from the oxalate precipitations, and metal scrap from metal fabrication operations.

### Health Instruments and Indoctrination

6.42 The very important "watchdog" functions of Group CMR-12 included monitoring and decontamination activities in the Technical Area, DP Site (both West and East Areas), responsibility for care and use of counters and meters for detecting radioactivity, and laundry functions of contaminated protective clothes and respirators.

6.43 W. H. Hinch was the group leader until he left the project March 26, 1946. Then J. F. Tribby accepted the position.

6.44 Throughout 1946, the HI Group (CMR-12) increased the amount of monitoring work done in the various division areas. Besides this "police" work, much effort was placed in educating the personnel in the importance of the health safety rules and regulations. It was difficult to instill respect for some of the procedures in both the scientific and production personnel. This indoctrination was carried on in collaboration with the Health Group, who had experienced this same lack of interest from employees with regard to routine examinations (2.75).

6.45 This group also started investigations to develop radiation detection equipment which was more stable, more rugged, and more sensitive than previously used types.

## Chapter VII

### EXPLOSIVES DIVISION

#### Organization of X-Division

7.1 A glance at the early arrangement of X-Division (Vol. I, 16.1) reveals a complex organization composed of many groups and subgroups. This complexity, as explained in Volume I, arose from the rapid growth of the division and the number of functions it had absorbed from other divisions (primarily some of the Gadget Division and Ordnance Division activities).

7.2 The trend for organization in X-Division, as well as other technical divisions, was toward simplicity of structure. This was a move caused by both insufficient personnel and the discontinuance of certain wartime programs. Groups necessarily had to be combined to utilize the diminishing staff to the best advantage and to concentrate on the peacetime research problems of greatest importance.

7.3 G. B. Kistiakowsky returned to Harvard University in October 1945, leaving Max F. Roy, as division leader, to cope with reorganization.

7.4 The reorganization of the Explosives Division was virtually completed in January 1946. The work of subgroups X-1B Terminal Observations and X-1C Flash Photography was transferred to the newly formed M-Division. The personnel and functions of Group X-2 Engineering, Group X-5 Detonating Circuits and Group X-6 Assembly and Assembly Tests were transferred to the Z-Division. Subgroup X-1D Rotating Prism Camera became Group X-8 under A. W. Campbell, and subgroup X-1E Charge Inspection became Group X-1 Radiographic Research under G. H. Tenney. Subgroups X-3A and X-3B were combined as Group X-2 Explosives Research with E. R. Van Artsdalen as group leader; X-3C, X-3D and X-3E were combined as Group X-3 Explosives Production with L. E. Hightower as group leader. The functions of

Group X-4 were changed, from Mold Design, Engineering Services and Consulting, to a general investigation of materials suitable as slow explosives, with J. W. Stout as group leader. These changes left the following organization:

X-1	Radiographic Research	G. H. Tenney
X-2	Explosives Research	E. R. Van Artsdalen
X-3	Explosives Production	L. E. Hightower
X-4	Slow Explosives	J. W. Stout
X-7	Detonators	K. Greisen
X-8	Detonation and Shock Phenomena	A. W. Campbell

7.5 Several further changes were effected during the year. With the loss of senior personnel in Group X-4, the functions of this group were transferred on June 15, 1946, to Group X-2, as a section of that group. With the departure of E. R. Van Artsdalen from the project, M. L. Brooks was made group leader of Group X-2 on September 16, 1946, and L. B. Seely replaced K. Greisen as group leader of Group X-7 on June 15, 1946. A new group, X-6 Detonation Physics, was activated on November 1, 1946, under J. C. Clark, to study detonation and shock phenomena with flash X-ray techniques.

#### RADIOGRAPHY GROUP

7.6 Group X-1, under the leadership of G. H. Tenney, continued their program of investigation of radiographic methods for the inspection of explosive charges for the division. In addition, radiographic inspection techniques for the examination of nonexplosive objects were developed and used.

7.7 The program of research was further increased by special work on the radiographic possibilities of various radioactive sources available at Los Alamos. As a result of a meeting held April 9, 1946, a 14-curie RaLa source was obtained for fundamental radiographic experiments on steel. The first tests using this source were performed June 20, 1946.

7.8 A lead cylinder, equipped with a conical lead cover and a special lead shutter functioning by remote control, had been constructed to hold the source.

7.9 This preliminary experiment showed that RaLa, as one of the obtainable isotopes, could be used for industrial radiography. Further investigation on this phase of radiography was suspended until additional personnel could be obtained.

7.10 Research work was considerably curtailed the latter part of 1946, as a result of a fire on November 19, 1946, which destroyed one X-ray room and one darkroom at T-Site.

#### THE EXPLOSIVES RESEARCH GROUP

7.11 The research program of this group under E. R. Van Artsdalen and later under M. L. Brooks included studies on slow explosives, thermal properties of cast explosives, development of faster, more powerful high explosives, measurements of the physical properties of cast HE, and casting of special explosive charges.

7.12 As previously stated (7.5), Group X-4, Slow Explosives, was absorbed by the Explosives Research Group in June 1946.

#### EXPLOSIVES PRODUCTION

7.13 Shortly after the close of the war, the production of full scale lenses (by Group X-3) ceased, except for experimental purposes and process development. This cessation of activity resulted from lack of personnel, and the unsafe character of the buildings in which this work had been carried out. The last full scale charge (although not the last full scale casting) was made in Building S-25 at Los Alamos in October 1945.

7.14 By this time, it was possible to make full-scale lens castings on a production line basis.

7.15 Group X-3 was under the leadership of Major J. O. Ackerman, until November 15, 1945. At that time L. E. Hightower assumed the position of group leader, and Major Ackerman acted in an advisory capacity.

7.16 Production was completely stopped on December 19, 1945, because the water shortage had become so acute. Prior to this official closing, the group had been severely handicapped by low water and low steam pressure on several occasions.

7.17 The main problem confronting this group, after the water situation had cleared, was the hazardous condition of its production lines (1.35). The casting line for experimental lens production, S-31, at last reached such a dangerous state of deterioration that it was closed early in 1946 for renovation.

7.18 But in April 1946, at least two months before the reconstruction had been completed, S-25, the casting building for the full scale lens, was

closed because it was no longer safe to operate, and all equipment was moved back into S-31. Building S-25 remained closed for the remainder of the year, and all production was continued in S-31, even though that line had not been finished.

7.19 By the fall of 1946, the Casting Plant at the Naval Ordnance Testing Station, Inyokern, California, had come into operation and relieved the group of the necessity of full scale charge production.

7.20 The Los Alamos group then concentrated on the preparation of scale castings for experimental work on process technology.

### DETONATION PHYSICS

7.21 The high speed flash X-ray photography, which proved so useful during the war, was revived for the study of detonation waves and of shock waves in substances arising out of high explosive detonation. This work was the responsibility of Group X-6, organized in November 1946, with J. C. Clark as group leader.

### DETONATOR PRODUCTION

7.22 Detonator production, Group X-7 under K. Greisen until June 15, 1946, when L. B. Seeley, Jr., became group leader, was concentrated on improving the quality of the product.

7.23 In April 1946, the operation of standard detonator loading was moved from South Mesa Site to Two-Mile Mesa. After this transfer, only experimental detonator loading was continued at South Mesa. This new location gave considerably more working space to the group.

7.24 Procurement difficulties arose in April and May, when the Detroit Centerline plant was reorganized and operations temporarily ceased. It was impossible to secure detonator parts during this period, but detonator production was maintained at Los Alamos by using the entire stock of parts on hand and salvaging others from rejected lots.

### Detonation and Shock Phenomena

7.25 Studies in shock wave and detonation phenomena continued during

this period by A. W. Campbell's Group, X-8. Experimental firing of full scale lenses, experimental charges, plane wave shots, and initiation of Composition B were all carried out at Anchor Ranch Site.

7.26 One of the most interesting phases of the work done by this group was testing the special slow components. These studies were vigorously pursued from early in 1946 until the end of the year, but the results were not conclusive.

7.27 The problem of increasing the intensity of the blast luminosity of the surface was materially solved by this group in October 1946. It was found that the addition of calcium peroxide on the surface of an explosive proved very effective in its intensifying actions. The only flaw in this method was the need to improve the cohesive material between the calcium peroxide and the explosive. At the end of the year, experiments were still in progress to locate a better substance.

7.28 Experiments were started the last of 1946 to test the effect of cavities in explosives on the emergent detonation wave.

## Chapter VIII

### ORDNANCE ENGINEERING (Z) DIVISION

#### Organization of Z-Division

8.1 Although Z-Division had been created in July 1945 (Vol. I, 9.13), the new organization remained in a fluid state until the latter part of September 1945. About that time a somewhat formal organization existed, with the following groups and subgroups:

Z-1	Experimental Systems	Comdr. N. E. Bradbury
Z-1A	Airborne Testing	Dale Corson
Z-1B	Informers	J. B. Weisner
Z-1C	Coordination with Using Services	Glenn Fowler
Z-2	Assembly Factory	Col. L. E. Seeman
Z-2A	Procurement, Storage & Shipment	Col. R. W. Lockridge
Z-2B	Production Schedules, Manuals	R. S. Warner, Jr.
Z-3	Firing Circuits	L. Fussell
Z-4	Mechanical Engineering	R. W. Henderson
Z-5	Electronic Engineering	R. B. Brode
Z-6	Mechanical Engineering for Production and Sandia	-----

8.2 J. R. Zacharias remained division leader until he returned to M.I.T. on October 17, 1945. At that time Roger S. Warner assumed the division leadership.

8.3 During the course of the next six months, two administrative problems became evident. The operation of the ordnance engineering division was becoming increasingly difficult in view of the division of its activities between Sandia and Los Alamos. Furthermore, the pressure of lack of housing at Los Alamos was such that the Laboratory was searching for almost

any means of relief. It was accordingly decided to initiate a move of the entire division to the Sandia Laboratory as rapidly as this could be effected.

8.4 In March 1946, this plan was executed, and all groups, except Z-4, were reorganized and a transfer to Sandia began. The housing situation at Sandia was little better than at Los Alamos and tended to retard the transfer, which was not completed until July 1946. Group Z-4 Engineering, under R. W. Henderson, remained at Los Alamos until February 1947.

### Program of Z-Division

8.5 Roughly, the Z-Division program embraced the following five parts: Testing, Design, Development, Stock Piling, and Bomb Assembly.

### TESTING PROGRAM

8.6 Two weapons were existent in August 1945: the "Little Boy" (U<sup>235</sup> gun assembly) and the "Fat Man" (plutonium implosion assembly).

8.7 The Fat Man weapon presented other difficulties: First, its absolute degree of reliability was unknown to the extent that the factor of safety in each component was unknown, and all that had been proved in a certain number of tests was that no failure had been experienced. The next drop, however, could never be predicted with confidence. Second, the mechanical, electrical, and nuclear complexity of the weapon were such as to require the use of men with the highest degree of training, responsibility, and experience whenever field experiments were performed.

8.8 In order to get reliable statistical data on the performance of each individual component, it was necessary to devise some system whereby actual conditions experienced by the bomb in flight could be duplicated in the laboratory under controlled conditions. To achieve this, a program of telemetering flight information from the falling bomb was undertaken. It is noteworthy that the information of primary interest to the project was, for the most part, different from that which the conventional telemetering employed and, to this end, a comprehensive telemetering development program was instituted. Flight information recorded included roll, pitch, yaw, vibration frequency, temperature, and pressure.

8.9 The philosophy behind such an informative program lay in a belief that once the conditions experienced by a bomb in flight were known, then such



conditions could be duplicated upon the ground in a test laboratory and, in addition, could be made as severe as desired. The behavior of each component of the weapon could then be tested and its point of failure ascertained. The weak points would then be strengthened and a safety factor for the weapon, as a whole, established.

#### DESIGNING PROGRAM

8.10 At the close of the war, the Laboratory found itself in the position of having no concrete guides from higher authority, but, at the same time, was faced with the necessity of holding together the highly experienced group of design and development technicians. The experience gained during the war served to impress the fact that the Fat Man, as it was used at Nagasaki, could hardly be called anything more than a scientific gadget; it was certainly not a weapon. Its assembly and use demanded the highest type of technical personnel in large numbers, which is certainly incompatible with modern warfare.

8.11 In view of this crude design, it was decided to direct the efforts of the Ordnance Engineering Division toward the re-engineering of that weapon to make production easier, to simplify the assembly technically required at an advanced base, and to minimize, if possible, the previous requirement of highly trained assembly personnel.

8.12 In other words, a program of production engineering was instituted to clean up an existing explosives design. With this as the primary objective it was decided to do whatever possible to improve the ballistics of the bomb, subject to the dimensional restrictions imposed by the dimensions of the B-29 bomb bay.

#### STOCK PILE PROGRAM

8.13 One of the responsibilities of Z-Division was the production engineering and procurement of all bomb components and material required for the national stockpile. This activity includes testing all components, processing them through various tropicalization procedures, packaging, storage (in facilities controlled by others), and continued surveillance of all material to determine effectiveness of packaging and to guarantee against deterioration. The only bomb component which did not come under the division's jurisdiction as far as stockpiling is concerned was the Pit assembly.

## BOMB ASSEMBLY

8.14 As mentioned in the preceding paragraph, Z-Division was responsible for the packaging and storage of bomb components. This packaging operation in the broader sense included the assembly of high explosive charge around the pit. A production line was operated which assembled all of the incoming components into the proper units for long term storage. In addition to this work the Division assembled a considerable number of bombs for use in the proof-testing of individual components both in the Laboratory and in free flight.

8.15 To successfully carry out this program, a Mechanical Test Laboratory was established at Sandia during August 1946, in which a complete set of various testing devices was installed, for the purpose of obtaining statistical data on the performance of individual components. This work included vibration testing, under all conditions of temperature and pressure to which the particular components might be subjected, in a tactical operation. Among other facilities, a large altitude chamber was installed which could test a complete bomb assembly as far as pressure, temperature, and humidity were concerned, but lacked integral shaking facilities. The simulated altitude of the chamber may be varied from 40,000 feet to sea level at a speed of some 2000 feet per second during which temperature, pressure, and humidity may each be controlled independently.

8.16 As early as January 1946, a great number of division personnel were enlisted in the preparations for Crossroads Operation (1.41). The division leader, Roger Warner, went overseas the latter part of March, leaving Dale R. Corson, as acting division leader. By April, many of the Ordnance Engineer groups were entirely taken over by B-Division. The Informer Group, for example, were practically all engaged in work for the Bikini tests and the program of vibration study was suspended until after July 1946. This same situation was true in the Fusing and Firing Group. Due to the interruption by Operation Crossroads, the telemetering program was very slow in getting started, and only towards the end of 1946 did the telemetering devices begin to repeat what was fed into them from the pick-up devices, rather than report their own "shake and shiver." The most serious factor resulted from the Assembly Group being involved in overseas duty, leaving scarcely any men trained in bomb assembly and testing. The gravity of this predicament was evident, and brought forth a recommendation that assembly operations ultimately be turned over to a purely military organization, which would include officers and men, preferably with backgrounds in electronics, mechanical engineering, and high explosives. This group would be assigned permanently at Sandia and would engage in the laboratory production

program.

8.17 This recommendation became factual in July 1946, when a U. S. Army Special Battalion was formed to take over the surveillance, stockpiling, field tests, and assembly work, as well as field work in connection with the development of new models. It was planned to divorce the civilian organization from the Los Alamos Laboratory set-up, with the intention that it should become a permanent Civil Service adjunct to the Special Battalion as fast as possible.

8.18 It is noteworthy that this operational philosophy began to swing in the opposite direction during the first part of 1946, and was accelerated with the arrival of Col. H. C. Gee as Area Manager in the fall of 1946. Instead of a military operation of the development program with civil service employees in a supporting role, the trend gradually swung toward a completely civilian operation under the University of California contract. The reasons for this are many, but in general it was considered that temperamentally as well as from a standpoint of primary interest it was not feasible to have a military organization in a responsible developmental position.

8.19 Dale Corson left the division in July 1946, while Roger Warner was still overseas on Operation Crossroads, and Lt. Col. E. E. Wilhoyt became acting division leader.

### Organization as of December 1946

8.20 At the end of 1946, Z-Division was organized in the following groups:

Division Leader:	Roger Warner
Alternate Division Leader:	Lt. Col. E. E. Wilhoyt
Z-1 Field Test	Glenn Fowler
Z-2 Mechanical Engineering	R. A. Bice
Z-3 Assembly Training	Arthur Machen
Z-4 Engineering (Los Alamos)	R. W. Henderson
Z-5 Firing and Fusing	O. L. Wright
Z-6 Mechanical Laboratory	Alan Ayers
Z-7 Production	J. L. Rowe
Z-8 Informers	William Caldes
Z-9 Stock Piling	Wilbur Schaffer
Z-10 Supply	Henry Moeding
Z-11 Little Boy	Harlow Russ

## Chapter IX

### DOCUMENTARY DIVISION

#### Introduction

9.1 In the development of the Laboratory from its inception in 1943, a substantial number of technical staff groups were formed in order to solve the special problems as they were encountered. All of these groups reported directly to Project Director, Dr. J. Robert Oppenheimer, and later to Dr. N. E. Bradbury, as Laboratory Director. Some of these groups were dissolved when the functions were transferred to other agencies or with the disappearance of the problems involved.

9.2 The technical staff organization functioned effectively by reason of the full acceptance of responsibility by the very competent group leaders with little or no supervision from the Director (2.5). These group leaders in many cases were men with outstanding professional background which made them exceptionally valuable in other fields of endeavor. For example, Ph.D.'s and graduate students who had majored in theoretical physics, mathematics, and philosophy were engaged in technical editorial work, cataloging, report writing, declassification procedures, and history preparation.

9.3 With the general exodus of personnel, starting in the fall of 1945, many of these group leaders left these assignments for other activities. As a result, the functions of some of these groups were interrupted or left in the hands of remaining junior members who needed direction. The relaxation of security from the wartime stringency which compartmentalized substantially all activities, and the consequent greater exchange of information between projects, permitted the establishment of central uniform Manhattan Project procedures for the handling of much technical information. This required considerable alteration of the informal wartime practices of the Laboratory.

Consequently, there was a great burden thrust on the Director to effect many new procedures while at the same time he was losing most of his unusually well-trained technical staff for handling these matters. The many other responsibilities of the interim period discussed in Chapter I prevented the Director from giving these staff functions any considerable time; hence, the groups tended to lose their effectiveness.

### Formation of D-Division

9.4 When Major Ralph Carlisle Smith, the local Patent Advisor, returned from his security and technical advisory assignment to the Operations Crossroad press ship, U.S.S. Appalachian, he was requested by the Director to consolidate the technical staff groups, other than the health group, into a division, and ultimately to take over the duties of an Assistant Director. On August 21, 1946, the Director announced the formation of the Documentary (D) Division with the responsibility for Technical Series editorial work; the Document Room; the Technical Library; editorial revision, review and control of reports; information dissemination; declassification; history; and various other technical services, with Major Ralph Carlisle Smith as Head and Herbert I. Miller as alternate. Although the contractor did not assume responsibility for Patent control, this being the delegated responsibility to Smith from the OSRD Patent Advisor, Captain R. A. Lavender, U.S.N. Ret., this control was exercised in the Documentary Division as a dual responsibility of its leader. Later when Mr. E. J. Demson left the project in 1946, Major R. C. Smith also accepted the project responsibilities of an Assistant Director, particularly the legal duties of Mr. Demson. This new arrangement removed a considerable load from the Director and by reorganization of the accumulated staff groups, so as to use the available professional personnel in several phases of the work, it was possible to improve the services of the staff groups with a smaller number of employees. The responsibilities were generally divided as follows: Patents and Legal, Library and Document Room, History and Technical Series, Report Editing - Review, Classified Information Dissemination, Declassification, Drafting (Patents, Reports and Miscellaneous), Technical Illustrations and Art Work.

9.5 The group organization for D-Division during 1946 was the following:

D-1	Legal	Ralph Carlisle Smith
D-2	Library	G. F. Campbell
D-3	Review and History	R. R. Davis
D-4	Editorial	J. F. Mullaney
D-5	Design and Drafting	L. F. Jacot
	Records and Administration	A. M. Frazier

9.6 Most of the functions of D-Division have been covered in the discussion under the technical staff groups of Vol. I, (3.82 to 3.87 and 3.123 to 3.128). There are a few phases, however, which are new and which merit additional comment.

### THE TECHNICAL SERIES\*

9.7 In conformity with other sections of the Manhattan Project, a program was initiated to record, in accessible and edited form, the technical knowledge and gains of the Laboratory. In principle, it was proposed to prepare a "Handbuch der Los Alamos" in analogy with the famous Handbuch der Physik. Titles for seventeen volumes were established in August 1945, as well as volume, and, in some cases, chapter and section editors. Difficulty in establishing a title for the over-all work arose. The original name "Handbuch der Los Alamos" was misleading in its English translation, so the title Los Alamos Encyclopedia was substituted. But inasmuch as it was decided that "encyclopedia" implied an alphabetical arrangement, that too was discarded and the "Los Alamos Technical Series" was finally chosen (Appendix 7).

9.8 Dr. Hans Bethe and Dr. David Inglis were originally responsible for this compilation with the following staff of volume editors

Volume No.	Title	Editor
0	"Relation Between the Various Activities of the Laboratory"	S. K. Allison
1	"Experimental Techniques"	Darol K. Froman
2	"Numerical Methods"	Eldred C. Nelson
3	"Nuclear Physics"	R. R. Wilson
4	"Neutron Diffusion Theory"	George Placzek
5	"Critical Assemblies"	O. R. Frisch
6	"Efficiency"	V. F. Weisskopf

\*See editor's note, Appendix 7.

Volume No.	Title	Editor
7	"Blast Wave"	Hans A. Bethe
8	"Chemistry of Uranium and Plutonium"	Joseph Kennedy
10	"Metallurgy"	Cyril S. Smith
11	"Explosives"	G. B. Kistiakowsky
12	"Implosion"	R. F. Bacher
13	"Theory of Implosion"	R. E. Peierls
21	"The Gun"	F. Birch
22	"Fuzes"	R. R. Brode
23	"Engineering and Delivery"	N. F. Ramsey
24	"Trinity"	K. T. Bainbridge

9.9 Only Volumes 1 and 2 have been considered completely declassifiable under the existing standards. However, a substantial portion of the information in some of the others will eventually be declassifiable and, with the exception of the weapon data, the remainder was to be distributable throughout the Manhattan Project for its general benefit.

9.10 Shortly after the initiation of the program, Dr. David Hawkins and Robert R. Davis were assigned the responsibilities of the Technical Series because of the imminent departure from Los Alamos of both Dr. Bethe and Dr. Inglis. When Dr. Hawkins left the project in the late summer of 1946, Robert R. Davis took over the detail as a group leader in D-Division.

9.11 The Technical Series compilation has proceeded at a slow rate since the time of its inception. Exceptional delays resulted because many individuals were reluctant or unable to continue obligations, taken on while at Los Alamos, after their departure. A more understandable difficulty was experienced by active project personnel who were faced with the problem of conducting an active technical program while writing about one accomplished in the past.

9.12 By January 1947, Volume 0 and 22 were completed and issued, and two-thirds of Volume 1 had been issued.

#### DESIGN AND DRAFTING GROUP

9.13 The Technical Series Group and the Technical History Group had acquired a drafting section for the purpose of illustrating their volumes. In addition, a design and drafting section was in existence to aid the Patent Group. The Report Editorial Group was serviced by the Shop Group Drafting Section, A-3, and the Post Historian used the Post Operation drafting staff

in the Army Civil Service organization. Furthermore, the Ordnance Engineering (Z) Division had a Technical Illustration Group that was required to prepare exploded views of the weapons and their components, to do general art work for the project, and to do instructive illustrations for the manuals prepared by Z Division on weapon assembly and handling, and by X Division on high explosive and detonator production techniques. The Technical Series, History, Patent, and Technical Illustration Drafting Sections were combined into a single Design and Drafting Group so that duplication of effort would be avoided, and the over-all staff group personnel requirements would be reduced. In addition, groups of the Documentary Division were no longer required to call on outside drafting agencies, thus relieving their work load.

9.14 It was found that one-half the drafting staff was able to carry the entire load and, in addition, the year back-log of work in the Report Editorial Group was completely wiped out, not only by completing illustrations, curves, diagrams, and the like for the reports, but also in the detailed and tedious printing of involved mathematical formulas by the drafting group. The Technical Illustration and Art Staff functioned substantially independently of the remainder of the group, but by limiting its responsibility, it was able to direct its effort to the primary assignment of preparing exploded views, manual illustrations, and art work so that considerably greater production resulted.

#### DECLASSIFICATION PROGRAM

9.15 Shortly after the termination of hostilities, many individuals requested permission to publish papers on phases of the Laboratory research and development which they did not consider classified. The procedure for handling these items was not clear-cut and generally unsatisfactory. A few items were released through the local Security Office by its Washington headquarters, but the informal and uncertain treatment left much to be desired.

9.16 After the Tolman Committee recommendations on a program of declassification were adopted by the Manhattan Engineer District, the Laboratory established in June 1946 a special scientific staff under the direction of Frederic de Hoffmann, on loan from Harvard College, to review all the Los Alamos formal reports to see which might appropriately be submitted for declassification. Many reports required careful rewriting in order to remove classified information or to overcome indications of classified applications.

9.17 A procedure was established whereby a member of the technical staff of the Declassification Group reviewed a report or a rewritten version thereof to determine whether or not it should be submitted for declassification.



When a report was so approved for processing, it was routed (1) to the Technical Series Editor to be certain it was adequately covered in that compilation, (2) to a Responsible Reviewer, a senior member of the Laboratory scientific staff, to be approved for declassification according to a Guide prepared on the basis of the Tolman Committee recommendations, (3) to the Patent Advisor to be assured that the Government's interest was protected from a patent standpoint, (4) to the local Army Security and Intelligence Officer as a check against unnecessary revelation of physical security safeguards, (5) to the group leader of the Declassification Group to be certain that no releases were made on associated project work without permission from that project, and to send abstracts to the Manhattan Project Editorial Advisory Board for approval of publication, and (6) finally to the Laboratory Director for general over-all review and approval for submission to Oak Ridge declassification headquarters for declassification.

9.18 Although the foregoing routing seems involved, it was found that once the report was put in shape for submission for declassification, the processing could be accomplished in a day, except for the time required for detailed review by the responsible reviewer, and the patent advisor. Allowing ten days for review of a document by the Manhattan Project Editorial Advisory Board, declassification has been effected in a period of about two weeks if the subject matter has been clearly releasable. Of course there have been questionable cases and some items which have been refused declassification.

9.19 About 320 documents had been routed for declassification by December 31, 1946. Approximately 700 more were considered by the declassification group but never assigned numbers for routing because it was determined they were not declassifiable by that group. Of those processed, about 250 made the entire round and were approved for declassification in Oak Ridge before the end of 1946. It appears that about 50 of these documents were approved for publication or published in recognized scientific journals during the same period. The Laboratory is proud of its contribution to the scientific literature of the country.

9.20 An incidental service established by the declassification group, with the cooperation of the Library and Document Room, is the loan of declassified documents to former Laboratory staff members now engaged in research at other private and public institutions. These loaned documents are not considered publications but only private communications. They are loaned, not only for the purpose of aiding research in the nation, but also to advise the former staff members as to the extent of declassification and the limits of information which may be disclosed to others who did not have access to classified material. In the latter respect, it is believed to be a valuable security measure.

## Chapter X

### CONCLUSION

10.1 Inasmuch as national legislation was more deliberate in its development than had been anticipated, the Los Alamos Laboratory operated through 1946 on the general interim philosophy expressed in October 1945 by Dr. Bradbury, which was based on the local conception of the nation's present and future need for such a laboratory (Appendix 1).

10.2 It went forward on a research program in all the technical fields bearing on the development of the weapon, which fields include nuclear physics, chemistry, high explosives, equations of state, radiation, hydrodynamics, and phenomena of solids. Since most of the developments preceding this period had progressed on an almost entirely empirical basis, attempts were made during these sixteen months to increase the understanding of the processes involved.

10.3 The past chapters have evidenced that progress was made, but they have also brought out the fact that the Laboratory did not have a clear-cut picture of its future in the field of atomic energy. This still was to be decided by the new commission. The mission of the Manhattan Engineer District had been completed. The Atomic Energy Commission would, from January 1947, direct the course of Los Alamos and the other projects.

10.4 To help the commission in this task during its first visit to Los Alamos in November 1946, Dr. Bradbury wrote a brief account of the Laboratory's history, accomplishments, problems, and his suggestions (Appendix 9). The following paragraphs taken from this account reflect that once again the Los Alamos Laboratory faced a critical period:

10.5 "Your Commission now faces the problem of determining the character and future directives of Los Alamos. Unfortunately, the local project is so small that the problems of the community bear upon the character

of work done by the Technical Area, and reciprocally, the existence of the Technical Laboratory determines the existence of the community. While these problems can be discussed separately, their simultaneous successful solution is required for the success of either.

"The Los Alamos Laboratory does not presume to indicate to the Commission what the policy of that body should be with respect to the national need for atomic weapon development. Nor should the Laboratory as such express its views on the relationship of such a national program to the international scene. The discussion which follows is based upon the assumption that the United States will require, for an unknown time to come, a program in atomic weapon development and research. Such a program should be directed not only at maintaining an immediate superiority for the United States in this field, but towards maintaining general scientific progress and a concern for basic and long-range developments which will make for strength in the future. It is also assumed that the government of the United States must know what weapons might be arrayed against it for the proper formulation of its own national and international policies. The ensuing discussion is based in addition upon an assumption, which the Laboratory can only suggest, that the Commission shares with the established armed forces of the United States a responsibility for the security and defense of the country; that the atomic weapon plays a fundamental role in any security program set up at this time; and that, therefore, the Commission and the Army and Navy are jointly concerned with this problem.

"It has been noted that, up to the present time, the Los Alamos Laboratory has been responsible for the atomic weapon in its entirety. The atomic bomb has been employed by the armed forces exactly as received from Los Alamos and assembled with only Los Alamos personnel. There has remained, ever since the close of the war, concern as to the engineering reliability of the weapon as well as a conviction that engineering improvements were not only possible but desirable. The skepticism of the armed forces with respect to the ballistic determinations of Los Alamos personnel has already been apparent, and it may be anticipated that this feeling will grow to include the fusing and firing mechanisms and the complexity of weapon assembly. It is further noted that a demand is already apparent for weapons of somewhat different engineering properties--e.g., a weapon which will penetrate the surface of water and detonate at a pre-determined depth. Other requests from the armed forces including the guided missile investigators may be expected to appear shortly.

"It is the belief of the senior technical personnel at Los Alamos that this Laboratory should not attempt to carry out these purely ordnance engineering aspects of atomic weapon development. Conversely, it is strongly suggested that these problems should be handled using the Sandia Laboratory,

the existing ordnance facilities of the Army and Navy, as well as additional laboratories that may have to be set up.

"It is suggested to your Commission that the Los Alamos Laboratory may be most effective if its concern is limited to the nuclear components of atomic weapons including, naturally, the technique of supercritical assembly of active material. The Laboratory would then be expected to carry out research on both long-range and short-range modifications in the nuclear structure of atomic weapons, but would not be expected to present to ordnance engineering laboratories more than a functional design for a weapon with the exception of those parts intimately concerned with the nuclear reaction.

"Such a division of responsibility will clearly call for the most active liaison between this Laboratory and such other laboratories as are carrying out the engineering development. While such liaison will present problems, they are not believed to be insurmountable. To maintain the present philosophy and localize Los Alamos responsibility for complete weapon development will not only result in a practical strangulation of effort devoted to long-range research, but will curtail the responsibility of the armed forces in a problem in which they are presumably able and anxious to participate.

"It is further suggested that Los Alamos retain the responsibility for testing the nuclear reactions for new atomic weapons, but that such tests as have a purely military significance be carried out by the armed forces. The distinction which is intended is that of separating a test of the "Alamogordo" type from a test of the "Crossroads" type. In view of the limited facilities of this Laboratory, however, the most active assistance of the armed forces would be required in subsequent "Alamogordo" - type tests, but the directive responsibility would come from this Laboratory.

"Whether or not Los Alamos should be continued over a long period of time is doubtless a problem which will be considered by the Commission. This question has naturally received consideration here, and having received a tentative affirmative answer, has resulted in extensive programs of permanent construction. Many, but not all, of the activities proposed for this Laboratory should not be conducted near populated areas. The isolation of the site represents certain community problems which is largely if not entirely balanced for personnel now here by the attractions of the climate and of the present mountainous location. The isolation of the technical community is more easily handled by a policy of encouraging attendance at national and regional scientific meetings, both of regular scientific societies and within the Manhattan District. The absence of railroad connections has contributed to a somewhat higher cost of transportation of materials to the project. Not a negligible factor involved in a proposed change of location is the fact that a large number of technical personnel have remained with the project because they and their families enjoy this location more than urban communities.

It is hoped, should a new location be considered, that its advantages will be conspicuous.

"Should the international situation develop to the point at which the United States may cease to have any concern for further weapon development or production, the Los Alamos Laboratory program would require careful reconsideration. Since, presumably, this is not a point at issue at the present time, it need not be considered here except to state that the operations involving plutonium, the basic chemistry and physics, the fast reactor, the large Van de Graaff accelerator, studies of materials at high temperatures, pressures, and radiation densities are all activities which will undoubtedly play a role in the peaceful applications of atomic energy no less important than the role which they play in a program whose objective is weapon research."



## APPENDIXES

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## APPENDIX NUMBER 1

### DR. BRADBURY'S PHILOSOPHY

Outline of policy for interim period of Laboratory operation. Presented by Dr. Bradbury to Coordinating Council, October 1, 1945. (See Chapter I.)



October 8, 1945

Notes on talk given by Comdr. N. E. Bradbury at Coordinating Council,  
October 1, 1945.

What should be the philosophy under which we operate the project during this interim period?

- (a) No one can doubt that Government supported research in atomic energy problems will continue.
- (b) This project will be taken over by a commission created by legislation.
- (c) This at once suggests our first difficulties: The first hurdle is legislation; this may be such as to make it impossible for individuals of the high qualifications required to work under any commission.
- (d) Given good legislation, the commission itself may be poorly selected - under these circumstances, again the proper people will not work on an atomic energy project.
- (e) The legislation and the commission may come too late - the longer this is delayed, with its corresponding uncertainty, the fewer good people will remain.
- (f) Particularly, security regulations may be set up so as to make it impossible for people to work. Consulting may be done in certain engineering matters, and the consultant's mind compartmentalized. This is very much more difficult in the fundamental fields. Many people feel that they would prefer not to know secret things if this requires going out and not being able to make use of them in a University.
- (g) The direction in which a University or an industrial firm will go in the next few years is predictable. The direction in which this business will go is not.
- (h) All of the above things make it necessary to be explicit about the philosophy which one wants for the project.
- (i) Such a philosophy has three parts:
  - 1. We should set up a project to study the use of nuclear energy on an operating basis which is as nearly as possible operating in what we consider to be an ideal way, in which the emphasis

is as we consider it should be, together with even the derivatives of this emphasis. In other words, we should aim to turn over to the commission the best possible project that we know how to make. The commission may have other ideas - our ideas may not be their ideas. But in any event we will have set up a project which to us seemed a good project for peace time, interim, immediately post war period. If we do not do this, we cannot complain that the project of the future was set up wrongly.

2. The project cannot neglect the stockpiling or the development of atomic weapons in this interim period. Strongly as we suspect that these weapons will never be used; much as we dislike the implications contained in this procedure, we have an obligation to the nation never to permit it to be in the position of saying it has something which it has not got. The world now knows we have a weapon. How many or how good it does not know. To weaken the nation's bargaining power in the next few months during the administrations' attempt to bring about international cooperation would be suicidal. One hopes that weapon emphasis will decrease with time. We are not a warring nation - the mere possession of weapons does not bring about war. Will the administration attempt to bring about international cooperation in these matters? Who knows - if it is not, we are doomed anyway, but our doom may be delayed a few months or years by having bigger and better weapons. I think we must be hard in these matters. To bring peace by threatening war is possible; to bring peace by requesting and promising cooperation seems more dignified. But the request and the promise, and surely the threat, are both fortified by weaponneering now; and the results of weaponneering may be that it may never have to be done again.
3. The project will decrease in size as it goes from a war time basis to a peace time basis.

These are therefore the three things on which I believe that the project's modus operandi for the next six months must be built:

We will set up the most nearly ideal project we can.

We will not discontinue weapon research until it is clearly indicated that this can be done.

We will decrease the project in size so that it can be accommodated on the mesa on a civilian basis.

How does one go about setting up an ideal project to study the problem of the use of nuclear energy?

(a) These problems of the atomic nucleus are extremely difficult; the best men are required to solve them; how does one get the best men?

1. A good man will not work unless there is intellectual stimulation in the work which he is doing. Therefore we will set up in all divisions programs of fundamental research which are related, but may only be distantly related to the problems of nuclear energy and the manner in which it may be released. In this respect we will follow the policies of good industrial laboratories in which a man may set up his own field of research, but does not have to show either a profit or even a close connection with the business of his employer.
2. I shall accordingly request division leaders to present programs of research which are intellectually of interest and upon which good personnel may be persuaded to work. The extent to which these programs will be set up will depend upon the scale of the laboratory and to this question I will return. It must be noted that our borrowed tools of research must be replaced. This means the cyclotron, Van de Graaff, etc...
3. An immediate revision of our salary procedures is essential. Heretofore personnel have been hired on a no loss-no gain patriotic duty basis. This is all very well in war time. It is not applicable now. The project is just another employer and it must compete for its personnel with other employers who can offer - quarters close to civilization or in it, a predictable future, work which may be published and better, or at least different, living conditions.

How do we meet this competition? First we can state our moral assurance that atomic energy work will continue in some form. People now associated with it will presumably be the key personnel of future developments. (BUT - it may be in a form that is repulsive to all of us. This is the chance we take and must pay our personnel to gamble on).

We have a salary scale which has never been fully applied, but which appears to me to have the possibility of meeting our immediate requirements - if it is applied. In other words, I propose to adjust salaries of personnel who may be persuaded to remain with the project in accordance with their

responsibilities, and positions with respect to the project.

This I propose to do in advance of a threat from them to leave to take other jobs. However, on an emergency basis it may be necessary to meet offers from other institutions or industry and on competitive basis.

It will take time - at least a month or six weeks - to clean our financial house. Where necessary we may offer contracts extending to 1 July 1946, although the University of California may not be in business that long. Nevertheless, the contract requires that the agency taking over assume the unexpired obligations of the University and the General has told me that he will guarantee such a procedure.

I wish to digress a moment at this point while discussing salaries. We are in urgent need of a Personnel Director. Mr. Clausen has indicated to me that he has strong personal reasons for leaving in about a month. The problems of hiring personnel, terminating the employment of individuals no longer essential to the project and uninterested in taking jobs essential to the interim program of the project, as well as the placement services of the project - all these combine to place an extremely heavy burden upon the man accepting this responsibility. It should also be mentioned that the problem of hiring SED's on a civilian basis will shortly become urgent. Such men form one of our most obvious labor markets and as such, has the unusual advantage that we have had definite information about the man before we hire him.

A definite procedure is now being set up whereby all project personnel desirous of obtaining jobs on the outside are brought in touch with employers. No effort will be made to discourage this. In fact, the opposite will be the case. If the project cannot meet the offer made by an outside concern for any one of many reasons, then this man will be permitted to go. All the project will request is that he and we understand how his work is to be taken over if it is to continue, and when he may leave.

The project may make a counter offer - it will only make one; ultimately it will endeavor to make the offer before it is a counter offer. The project's offer should not be used as a lever in forcing up offers from the outside, and we will so request personnel interviewers who are informing us by copy of all negotiations with our personnel.

I have dwelt at some length upon salary procedures, but this is not because I believe that money can be made to answer all arguments. In many instances, the project would be unable to offer any salary at all that could persuade a man to stay. This is a feeling with which I am personally in the most hearty sympathy.

The argument of duty or patriotism can no longer be used. For myself, I feel that the bear which we have caught by the tail is so formidable that there is a strong obligation upon us to find out how to let go or hang on. For everyone to pack up and leave would appear to me to leave the more difficult problems of the future not only unsolved, but with no prospect of solution. This however, I will never use as an argument - if an individual derives some satisfaction from this feeling, very well - but it is not a duty and will not be approached as such.

In one respect, the members of the council have somewhat more responsibility to the nation than do the remainder of the staff. As key personnel, I must urge that if you concur in my belief that we must leave an operating project for the commission, it is then imperative that you consider the tasks of your groups, and that you advise me as to whether they should be continued or discontinued in the light of the philosophy that I am expounding. If they are to be continued, then you do not leave until you see a reasonably acceptable way for them to continue.

To sum up so far - I have said that our philosophy is to:

Leave the best possible project for our successors  
Continue weaponizing until it is clear that we can taper off  
Decrease the size of the project consistent with the housing  
facilities on the mesa.

To build the best possible project we must have:

Good men - this means reasonable salary scale,  
reasonable employment practices,  
a program of intellectually stimulating  
research but not directed towards  
weapons necessarily.

A group of good physicists, chemists, explosives experts, metallurgists, engineers, is not enough. The project must have a sound overall program if it is to be the ideal project for our successors. Accordingly, I come to:

4. What shall our general project program be as far as atomic bombs and atomic weapons are concerned?

A. ... We will develop internal modifications, possibly in the method of fusing, almost certainly in the method of detonating. ... We will set up a more careful program of gadget testing so that we will know the degree of reliability of each component. We will set up surveillance

tests which at least must have the possibility of extending over a considerable time. We will set up Sandia Field as a field test site. It may not last there for more than a year, but we will learn how the ideal field test site for weapons should be set up, and it can either stay there; be moved, or become, let us hope, unnecessary in the course of time.

- B. We will initiate the engineering of a new weapon whose aims should be - although again we hope it will never need use - increased reliability, ease of assembly, safety, and permanence; in short a better weapon. Much as we dislike them, we cannot stop their construction now. Possibly in six months, possibly in a year - maybe in a few years, weaponeering will stop, but our present lead is our chief weapon in procuring a peace - we must not lose it until that peace and that cooperation is established. In all this we will invite the cooperation of the established military services - at all levels and wherever they can contribute.
- C. We will propose subsequent Trinity's. The TR bomb was a bomb and not a weapon if you will permit the distinction. We are entitled to do this from two premises:
  - I. The use of nuclear energy may be so catastrophic for the world that we should know every extent of its pathology. How bad can this bomb (if it were made a weapon) be? I shall return to this premise again in connection with the Super. One studies cancer - one does not expect or want to contract it - but the whole impact of cancer on the race is such that we must know its unhappy extent. So is it with nuclear energy released in this form. It can be a terrible thing; we cannot hide our head in the sand; we must know how terrible it is.
  - II. The occasional demonstration of an atomic bomb - not weapon - may have a salutary psychological effect on the world - quite apart from our scientific and technical interest in it. Properly witnessed, properly publicized, further TR's may convince people more than any manifesto that nuclear energy is safe only in the hands of a wholly cooperating world.



III. It also may be pointed out, that I believe that further TR's may be a goal which will provide some intellectual stimulus for people working here. Answers can be found; work is not stopped short of completion; and lacking the weapon aspect directly, another TR might even be FUN.

D. We will propose that the fundamental experiments leading to the answer to the question "Is or is not a Super feasible?" be undertaken. These experiments are of interest in themselves in many cases; but even more, we cannot avoid the responsibility of knowing the facts, no matter how terrifying. The word "feasible" is a weasel word - it covers everything from laboratory experiments up to the possibility of actual building - for only by building something do you actually finally determine feasibility. This does not mean we will build a super. It couldn't happen in our time in any event. But someday, someone must know the answer: Is it feasible?

5. We have now contended that our ideal project will have good men obtained by a good fundamental program and good employment practices; and that it will have a weapon program; that it will have a TR bomb program; and that it will have a feasibility of Super research program. Now I claim that it must also begin to worry about a program of research leading to the peace time application of nuclear energy. I am well aware that this has been worried out and carefully considered elsewhere. We must also do it here. For this program alone will receive the united support of all people everywhere. For the present I do not see how to fit such an effort into divisional, group, or sectional lines. Specific suggestions are needed as to how to go about this within the general frame of our present organization. At this moment I am too uninformed about the situation to do more than generalize.

I now propose to discuss the question of how the project will decrease in size during the next three to six months.

- a. Some people are leaving now; others will continue to drift away; this will go faster and faster as long as policies are either unformed or unimplemented.
- b. The post will probably continue as a military organization and

probably with adequate personnel for at least as long as it takes to set up the commission.

- c. The two year service rule will begin to take our SED's in large numbers about Christmas. Meanwhile, we will lose them more slowly by point discharge.
- d. SED replacements will probably be more or less available to some extent. They will, however, be untrained and generally less useful.
- e. I therefore conclude that the project will be - insofar as the technical area is concerned - on a largely civilian basis by next March. There will be SED's but they will be relatively fewer; they will live in barracks, and they will not present a housing problem.
- f. These civilians will come from three sources: People now here; new people hired; and SED's hired as civilians after discharge. All of these people who are married will sooner or later demand quarters as the price of staying. It will accordingly be necessary to revise our housing policy in the following way:

All people essential to operating a project must be housed in a way that will keep them here. This means, in addition to obvious personnel, that machinists, truck drivers, lower grade technicians will get quarters - unless key personnel wish to say that they can get along without them!

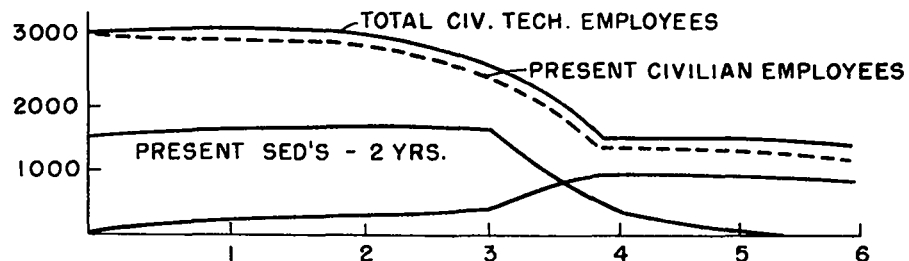
We have approximately 488 family quarters. Of families living in such quarters, possibly 25% of the wives may work. Thus, we can house in family quarters about 600 technical and post civilian employees. Possibly we may have a one to one ratio of unmarried to married personnel. This means another 500 or so civilians in dormitories. There will thus be a total of about 1,100 technical and post civilian employees. We now have about 3,000 in technical activities.

I therefore suggest that in about three to six months we must be prepared to adjust our scale of technical activity to about 1/3 of its present magnitude. I have not included SED's in this figure for I believe that the necessity of giving many more lower employee classifications housing will balance the extra assistance we will get from SED's living in barracks.

Accordingly, I will have to ask that all estimates of future activity be based on about this 2/3 decrease in rate of working. Each activity will be asked how many it needs in all classifications to

go on working at this rate - then these men must be housed. The day is rapidly going when the good machinists will live in dormitories away from their families. A similar statement may be made for S site - true they can hire people - but only with adequate living conditions.

It is curious that the activity of the mesa should be dictated by its housing, but I see no other alternative. I am sure the General will build no more quarters, as this would further commit the mesa to permanency. This I doubt if he will do.



What sort of personnel policies shall we have to bring all this about?

- a. Fair treatment of personnel leaving. This has been widely stated and agreed to. Hiring policies, 30 day, 90 day and contractual termination policies as well as dependents and household effects to be carried on as in the past.
- b. The matter of a 40 hour work week. This is under discussion at the moment - when do we get to it, I don't know. Many questions of policy are involved - all these are coupled with our failure to jump before or when the Civil Service jumped. Time is necessary to do these things.
- c. In order to make quarters available for long-termers, short-termers may be requested to terminate their connection with the project if they are unavailable for project jobs which now need doing. In all cases this will be in accordance with their employment agreement. However, the project will be cut in size, and quarters must be available for people coming in for the longer term - by long term I mean till 30 June 1946.
- d. How about personnel who lack degrees? Urge them to leave to

get them - but stagger their leaving and make some plans to get the good ones back.

Now for some rather specific questions which do not easily fit into project policies:

- a. The Handbook must be prepared. However, I doubt if it is desirable for a person to write 8 hours per day. In other words, having to write up work should not be an excuse not to take another job. It may be a part-time job and should be so considered.

The University must continue for at least this quarter, but in free time.

- b. What about the general organization of the project? In general I think the divisional organizations will stay about the same. However,

R and F might be combined

Z, G, X and T stay as they are

C and M might be split

Administration and Services badly needed - probably split into three parts: Personnel and general administration; procurement; technical services.

- c. What about the project of the future? We cannot say where it will be located. Economic considerations seem to indicate that to locate the project here on a permanent basis might tie it down to expensive maintenance (living, salaries) forever. However, this is not our question. Certainly it is difficult to see how it can start to move inside of 8 or 9 months and at least six or nine months for the moving which would take place gradually. DP Site will probably stay here until it is too contaminated to use. Could not be moved after it was started in operation. Thus the project will be largely here for at least another year.

I would like to see the project set up as the best type of industrial laboratory with much more emphasis possibly on fundamental things and with academic exchange thrown in for good measure.

What about SED's? I have indicated that I expect to lose them in large numbers about the first of the year. Otherwise, we can make no special effort to have them considered as different from any other SED's in the country, and particularly we can not attempt to get them treatment which differs from that prescribed by Army regulations and discharge procedure. We all know what we would

like to see done; and we will see that our SED's get the best possible consideration under the law; we will not attempt to have them treated above the law - we hope it will be a good one which will get them back to school as soon as possible. We cannot put them on ERC for practical reasons - we can't house them, and we can't let them go if we don't.

What about civilians with deferments? We must not set ourselves above the Selective Service Law. If we can certify that a man is needed to carry out the program outlined above, that he is actually essential to this program, we will continue to obtain deferments. Otherwise, we must release him. This means we must know our program. It is realized that this is unfair to the man - but war is by nature unfair. Some people get killed and some get rich quickly. Some people will experience this unfairness a little late, but no later than the boy who becomes 18 this month or next. Should not war be distributed over as many generations as possible to lessen the burden on any one?

How about security regulations? This is now set by the President. Liberal interpretations are coming as fast as possible. We can't close the box after the secret is out. Attempt to attain consistency. Fundamental problem has to WAIT.

The project of the future I would like to see have, with lifted security regulations, the possibility of exchange activities with academic institutions. People to come to the project for a year, and project personnel go to academic institutions for a year. Maybe on a similar arrangement on a part-time basis. Certainly on a consulting basis. All of this involves some lifting of security in fundamental fields plus even more fundamental problems of organization.



APPENDIX NUMBER 2

GROVES - BRADBURY LETTER

Copy of letter of approval by General L. R. Groves to outline policy by  
Dr. N. E. Bradbury. (See Chapter I.)





WAR DEPARTMENT

P. O. BOX 2610  
WASHINGTON, D. C.

4 January 1946

Dr. N. E. Bradbury  
P. O. Box 1663  
Santa Fe, New Mexico

Dear Dr. Bradbury:

It was my belief that the making of long-range plans with respect to the future of atomic energy should be delayed until after the passage of legislation so as to avoid serious commitments which might hinder the actions of whatever commission or other body should be established to take charge of the work. Unfortunately, no legislation has been passed, and certain forces are at work the effect of which has been to delay any legislative program.

It has therefore become necessary for me to make definite plans, despite the fact that this will commit to some extent at least any future control body. Our wartime effort was to end the war. Everything was sacrificed to that objective. We counted on suitable legislation being passed promptly at the end of the war. We should not count on atomic bomb development being stopped in the foreseeable future.

The Los Alamos site must remain active for a considerable period. Taking into consideration the type of work which must be done here, there has been found no site that combines as many desirable facilities for our work as Los Alamos. If one should be found, it would require at least six months to plan, twelve months to build, and six months to complete the move from Los Alamos. The only conclusion, therefore, is to stay at Los Alamos for at least the next few years, and to improve the existing facilities to such a degree as is necessary.

The major factors requiring improvement are the utilities, housing, and community facilities, particularly recreational facilities for single persons. This transition from war to peacetime community conditions will start immediately. To do this intelligently, however, requires planning, and this planning has already started.

With the current interest in the water situation, I wish to state my exact expectations with respect to this. First, all possible steps will be

4 January 1946

taken to maintain the existing system at maximum efficiency. This will include the trucking of sufficient additional water for as long as is necessary to supply continuous water service to all housing and to operate S Site and DP Site. Second, careful studies will be made with a view to securing a year-round supply based on 100 gallons per person per day which is considered adequate for a community with our industrial needs. Third, construction will be initiated promptly as soon as the plans have proceeded to the point where initiation of construction is feasible.

With respect to power and highway communications, it appears that the expected loads can be properly accommodated. If not, necessary steps will be taken to improve these facilities.

With respect to housing, we are assuming that DP Site will operate on a relatively permanent basis, and studies have been initiated with respect to layout and design of the needed family housing. It must be realized that there are certain legal restrictions which set a maximum cost of \$7500 per unit. This means that the most careful designs must be made in order that satisfactory permanent accommodations will be achieved.

With respect to community facilities, in addition to the recreation for single individuals already mentioned, there should be a wide range of consumer goods establishments and the stimulation of concessionnaires in this line is necessary.

Sincerely yours,

L. R. GROVES  
Major General, USA

LRG/b

APPENDIX NUMBER 3

CATALOG OF COURSES

Original list of courses and lectures offered by Los Alamos University (1.19).



September 17, 1945

TO: ALL TECHNICAL PERSONNEL  
SUBJECT: CATALOG OF COURSES

REGISTRATION

PLEASE NOTE CHANGED HOURS AND LOCATIONS. Registration will be held from Tuesday, September 18 to Friday, September 21 inclusive. The hours will be from 8:30 to 11:30 a.m. and from 2:30 to 5:30 p.m. in Room E-210. There will also be registration facilities in the High School from 7:00 to 9:00 p.m. in order to make registration possible for persons not employed in the Tech Area.

COURSES

UNDERGRADUATE - JUNIOR-SENIOR LEVEL

CHEMISTRY

11. Elementary Organic Chemistry.

Lecturer: M. F. Roy

Hours: Section I. Tues. & Fri. 10:30 - 11:45 a.m.

Sigma 47

Section II. Mon. 7:15 - 8:30 p.m. Gamma 49

Thurs. 8:45 - 10:00 p.m. Gamma 49

Prerequisite: Elementary Chemistry

Textbook: None

Description of Course: Study of the major general classes of organic compounds, their properties, reactions, and uses.

12. Elementary Physical Chemistry.

Lecturer: I. B. Johns

Hours: Wed. & Fri. 4:15 - 5:30 p.m. in Gamma 49

Prerequisites: Elementary Chemistry Calculus;  
Elementary Physics desirable.

Textbook: Getman-Daniels "Outlines of Theoretical Chemistry".  
(Required. Price \$3.50)

## CATALOG OF COURSES

Description of Course: This course will give the student a working knowledge of the fundamental principles of physical chemistry, including the study of gases, liquids, solids, the principles of thermodynamics, the theory of solutions, thermochemistry and its applications, the treatment of equilibria - both homogeneous and heterogeneous, chemical kinetics, electrolytic theory.

### 13. Advanced Physical Chemistry

Unfortunately, it has been impossible to secure a lecturer for this course. It will, therefore, not be given.

## METALLURGY

### 21. Physical Metallurgy

Lecturer: George L. Kehl

Hours: 10:30 - 11:45 a.m. Mon. & Wed. in Sigma 47

Prerequisites: Elem. Chem., one semester of Elem. Physics

Textbooks: (Recommended)

"The Alloying Elements in Steel" - E. C. Bain

"Engineering Physical Metallurgy" - R. H. Heyer

"Principles of Physical Metallurgy" - F. L. Coonan

"Principles of Physical Metallurgy" - G. E. Doan & B. Mahla

"The Science of Metals" - Z. Jeffries & R. S. Archer

"Principles of Metallography" - R. O. Homerberg & R. S. Williams

"Structure and Properties of Alloys" - R. M. Brick & A. Phillips

Description of Course: State of Aggregation; origin of metallic structures; crystal structure; equilibrium diagrams of metallic systems and their interpretation; non-equilibrium conditions in metallic systems; plastic deformation and annealing; non-ferrous metals and alloys; iron and steel; basic concepts of the heat treatment of steel.

## PHYSICS

### 31. Electricity and Magnetism

Lecturer: R. Brode

Hours: Mon. & Wed. 10:30 - 11:45 a.m. in Gamma 49

## CATALOG OF COURSES

Prerequisites: Sophomore Physics, Calculus

Textbook: Probably Page & Adams

Description of Course: Detailed discussion of the properties of electrostatic and magnetostatic fields. Electric currents and their magnetic fields, alternating currents, inductance and capacitance, oscillating circuits electric waves.

### 32. Modern Physics

Lecturers: B. Rossi and L. Parratt

Hours: Section I: Wed. & Fri. 9:00 - 10:15 a.m. Rm. B-223

Section II: Mon. 8:45 - 10:00 p.m. Rm. B-223

Thurs. 7:15 - 8:30 p.m. Rm. B-223

Prerequisites: Freshman & Sophomore Physics, Calculus.

A course in Electricity & Magnetism is desirable.

Textbook: "Introduction to Modern Physics" - Richmeyer & Kennard

Description of Course: The experimental and theoretical development which leads to the present concept of the constitution of matter. Beginning with the discovery of the electron, the course will discuss various methods of determining Avogadro's number, the structure of atoms, the atomic nucleus and cosmic radiation.

### 33. Electronics

Lecturers: D. K. Froman and Elmore

Hours: Section I: Tues & Fri. 10:30 - 11:45 a.m. Gamma 49

Section II: Mon. 7:15 - 8:30 p.m. Rm. B-223

Thurs. 8:45 - 10:00 p.m. Rm. B-223

Prerequisites: Differential & Integral Calculus. General College Physics. A course in Electricity and Magnetism (Physics) or a course in Alternating Currents (Engineering)

Textbook: Reich "Theory and Applications of Electron Tubes"  
(Recommended.)

Description of Course: Electric Circuits: fundamental laws and their application to complex circuits for D.C., sinusoidal A.C., and

## CATALOG OF COURSES

transient currents. Electron Tubes: parts and their functions; static and dynamic characteristics and their measurement; special tubes; some basic circuits. Electronic Circuits Design: detailed parts specification; applications to simple but complete electronics circuits. Basic Electronic Circuit Elements and Complete Circuits: emphasis on circuits for industrial control and scientific measurements rather than on radio, television, and radar.

### 34. Micro-Waves

Unfortunately the offering of this course at the present time seems to present insuperable difficulties generally connected with the confidential character of some of the information. It is hoped to give this course in the following semester if the courses are continued at that time.

## MATHEMATICS

### 41. Differential Calculus

Lecturer: P. Whitman

Hours: Wed. & Fri. 8:30 - 10:15 a.m. Gamma 49

Prerequisites: Analytic Geometry; Trigonometry.

Textbook: Granville, Smith & Longley "Elements of the Differential & Integral Calculus" (Required)

Description of Course: Differentiation of algebraic and transcendental functions; applications to slopes, maxima and minima rates, etc.; higher derivatives; differentials and applications to small errors, etc.; integration of standard elementary forms and application to simple areas, only if four hour course.

### 42. Differential Equations

Lecturers: J. W. Calkin & D. A. Flanders

Hours: Section I: Tues. & Thurs. 9:00 - 10:15 a.m. Gamma 49

Section II: Wed. & Fri. 7:45 - 9:00 p.m. Gamma 49

### 42. Differential Equations

Lecturer: J. W. Calkin



## CATALOG OF COURSES

Hours: Section I: Tues. & Thurs. 9:00 - 10:15 a.m. Gamma 49  
Section II: Wed. & Fri. 7:45 - 9:00 p.m. Gamma 49

Prerequisites: One year of calculus

Textbook: "Differential Equations" - H. T. H. Piaggio  
(Required.)

Description of Course: Ordinary differential equations of the first order, linear equations, miscellaneous special equations, existence theorems, numerical methods of solution, solution in series, selected topics in partial differential equations.

## GRADUATE

### CHEMISTRY

#### 61. Thermodynamics

Lecturers: G. S. Kistiakowsky and E. R. Van Artsdalen

Hours: Section I: Wed. & Fri. 9:00 - 10:15 a.m. Sigma 47  
Section II: Mon. 8:45 - 10:00 p.m. Gamma 49  
Thurs. 7:15 - 8:30 p.m. Gamma 49

Prerequisites: 1 yr. college calculus; 1 yr. college Physics and the elementary chemistry up to and including 1 yr. in Physical Chemistry.

Textbook: "Thermodynamics" - Steiner. (Recommended)

Description of Course: This is a course in chemical thermodynamics and because of time limitations it will not deal with topics of largely engineering interest (heat flow, heat engines, etc.) or of interest exclusively to physicists (such as the theory of thermo-electricity, etc.) The meaning of the three "laws of thermodynamics" will be discussed and they will be applied to the calculations of homogenous and heterogeneous chemical equilibria, vapor-solid equilibria, ideal and non-ideal solutions, surface tension, etc. The interpretation of the "Third Law" in statistical terms will be briefly discussed and the problem of the calculation of absolute entropies and of Free Energies of substances gone into in detail. The approach to all these problems will be of the type used by Gibbs (rather than the elementary approach as used by Lewis and Randall in their book, for instance) and hence those taking

## CATALOG OF COURSES

the course are expected to be familiar with differential and integral calculus, including partial differentiation. Otherwise the prerequisite is a course in elementary physical chemistry.

### 62. Radio Chemistry

Lecturer: J. W. Kennedy

Hours: Wed. & Fri. 4:15 - 5:30 p.m. Rm. B-223

Prerequisite: B. S. Degree in Chemistry or equivalent;  
or by special arrangement.

Textbook: None. Some reference books recommended including Davidson.

Description of Course: Natural radioelements, radioactive decay, nuclear transmutation, accelerating devices, radiations from radioactive substances, detection techniques, the study of radio-isotopes, new elements, chemical behavior at very low concentrations, carriers, tracers, exchange reactions, biochemical studies and other applications.

### 63. Theoretical Organic Chemistry

Lecturer: Mr. Lipkin

Hours: Mon. 9:00 - 10:15 a.m. Rm. B-223  
Thurs. 10:30 - 11:45 a.m. Rm. B-223

Prerequisite: 1 yr. Elementary Organic Chemistry  
1 yr. Elementary Physical Chemistry

Textbook: "Theory of Organic Chemistry" - Branch & Calvin  
(Recommended.)

Description of Course: Electronic structure of organic compounds; effect of resonance on the properties of organic systems; the relationship between physical properties and the structure of organic compounds.

## PHYSICS

### 71. Theoretical Mechanics

Lecturer: Mr. Keller

## CATALOG OF COURSES

Hours: Mon. 9:00 - 10:15 a.m. Sigma 47  
Thurs. 10:30 - 11:45 a.m. Sigma 47

Prerequisites: A. B. Degree in Physics, or equivalent amount of undergraduate Physics; Differential Equations.

Textbook: "Whitaker Analytical Dynamics"

Description of Course: A course in the dynamics of particles, rigid bodies, elastic media, and fluids. Topics to be taken up will include vector analysis; particle dynamics; Lagrange's equations; Hamilton's equations; rigid body dynamics; vibrating systems; coupled systems and normal coordinates; dissipative systems; elastic media and hydrodynamics.

### 72. Electro-Magnetic Theory

Lecturer: H. A. Bethe

Hours: Tues. & Fri. 10:30 - 11:45 a.m. Rm. B-223

Prerequisite: Calculus, Differential Equations, and an undergraduate course in Electricity and Magnetism, or its equivalent.

Textbook: Abraham & Becker (Recommended.)

Description of Course: The course will start by setting down and explaining Maxwell's equations. Various phenomena will be derived from these equations; a relatively short time will be devoted to electro-statics, an extensive treatment will be given of stationary currents and their magnetic fields and of high frequency electromagnetic waves. Electromagnetic cavity resonators and wave guides will be discussed. Relativity electrodynamics will conclude the course.

### 73. Statistical Mechanics

Lecturer: L. I. Schiff

Hours: Mon. 9:00 - 10:15 a.m. Gamma 49  
Thurs. 10:30 - 11:45 a.m. Gamma 49

Prerequisite: Theoretical Mechanics and Modern Physics  
Quantum Mechanics desirable.

Textbook: "Statistical Mechanics" - Tolman (Recommended.)

## CATALOG OF COURSES

Description of Course: First Part, General Theory (8 to 10 weeks). Introduction; classical statistical mechanics; detailed balance and the H-theorem; quantum statistical mechanics. Second Part, Application (6 to 8 weeks). (It will probably be possible to discuss briefly 3 or 4 of the topics listed below; these will be selected in consultation between students and instructor.) Free electron theory of metals; specific heats; electromagnetic radiation; fluctuations; imperfect gases; atomic nuclei; cooperative phenomena; equilibria in gases; reaction rates in gases.

### 74. Elementary Quantum Mechanics

Lecturer: E. Teller

Hours: Mon. & Wed. 10:30 - 11:45 a.m. Rm. B-223

Prerequisite: Theoretical Mechanics; Electromagnetic Theory;  
Differential Equations

Textbook: None for the time being.

Description of Course: A systematic description of the laws of quantum mechanics and their relation to classical physics. Specific topics to be discussed: correspondence principle, wave-particle dualism, uncertainty principle, Schrodinger- and matrix-formulation of quantum mechanics, the electron spin.

### 75. Nuclear Physics

Lecturers: Manley and Weisskopf

Hours: Tues. & Thurs. 9:00 - 10:15 a.m. Rm. B-223 (Section I)  
Wed. & Fri. 7:45 - 9:00 p.m. Rm. B-223 (Section II)

Prerequisites: One semester Quantum Mechanics; Modern Physics  
(Atomic Spectra, Structure Elementary Particles.)

Textbook: None

Description of Course: 1. Elementary particles and properties; 2a. Systematics of Nuclear Structure; nuclear reactions; alpha decay; fission. 2b. Observational methods. 3. Deuteron system, p-n scattering. 4. Theory of beta and gamma decay. 5. Theory of nuclear reactions.

## CATALOG OF COURSES

### 76. Neutron Physics

Lecturer: E. Fermi

Hours: Tues. & Thurs. 9:00 - 10:15 a.m. Sigma 47

Prerequisites: Differential equations; introduction to theoretical physics; a knowledge of the elements of Nuclear Physics; Introduction to Quantum Mechanics desirable.

Textbook: None

Description of Course: Neutron sources (radioactive sources, accelerating machines, piles) (1). Neutron reactions (capture, scattering, etc.) (6). Neutron detection (fast detectors - radioactive detection, counters, fission counters, etc.) (3). Slow neutrons (include diffusion theory, velocity selector) (6). Fission by neutrons, Chain reaction (2). Slow neutron piles (10). Fast neutron chain reactions (6).

### 77. Hydrodynamics

Lecturer: R. E. Peierls

Hours: Wed. & Fri. 4:15 - 5:30 p.m. Sigma 47

Prerequisites: Theoretical Mechanics, Differential Equations.

Textbook: LA-165

Description of Course: Kinematics of continuous medium. Lagrange and Euler variables, equation of continuity; Hydrostatics, Stresses, Definition of ideal fluid; Euler's equation; Bernoulli's theorem. Conservation laws. Vorticity; Thomson's theorem; Irrotational flow. Potential theory; Method of images; Complex variable; Flow around sphere and cylinder; Mapping; Flow around a corner; Airfoil theory; Application to free surfaces; Vortices. Viscosity; Equation for viscous flow; Poiseuille formula, flow between plates; Stokes law; Turbulence; Laws of similarity; Reynolds number; Examples of critical Reynolds numbers; Resistance coefficient; Boundary layers; Heat transfer; Theories of turbulence. Compressible fluids; Sound waves; Sound waves in medium of varying properties. Supersonic flow; Mach angle; Characteristics; Short waves; Hugoniot conditions; Rayleigh-Taylor theory. Interaction of short waves.



## APPENDIX NUMBER 4

### LOS ALAMOS UNIVERSITY STATISTICS

This chart shows approximate number of student enrollment in the Los Alamos University from October 1945 through June 1946. It also shows the number of earned credits.





<u>Course Name</u>	<u>Students for Credit*</u>	<u>Auditors*</u>	<u>Students Receiving Credit</u>
Theoretical Mechanics	14	16	7
Electro Magnetic Theory	24	36	5
Theoretical Organic Chemistry	14	9	10
Electricity and Magnetism	19	21	5
Modern Physics	32	36	13
Statistical Mechanics	5	12	5
Differential Equations	28	11	22
Elementary Physical Chemistry	6	7	5
Thermodynamics	26	28	6
Radio Chemistry	18	27	13
Differential Calculus	13	15	5
Physical Metallurgy	5	12	4
Electronics	13	22	5
Quantum Mechanics	18	31	11
Neutron Physics	15	21	4
Hydrodynamics	10	28	3
Electro dynamics	18	35	10
Nuclear Physics	1	32	1
	<u>279</u>	<u>399</u>	<u>134</u>

\*Approximate figure



## APPENDIX NUMBER 5

### REPORT OF UNIVERSITY AFFILIATIONS CONFERENCE

Complete program of university affiliations conference held at Los Alamos Laboratory July 1946, including discussions, conference representatives, and schedules (1.23).



UNIVERSITY AFFILIATIONS CONFERENCE DISCUSSIONS

Los Alamos Laboratory  
Los Alamos, New Mexico  
19 July 1946

INDEX

List of University Representatives and Colleges

List of Los Alamos Representatives

Program

\*List of Declassified Papers

Opening Remarks by Dr. N. E. Bradbury, Director

Description of Physics Division Activities

by Dr. John Manley

Description of Chemistry Division Activities

by Dr. E. R. Jette

Description of Experimental Physics Division Activities

by Dr. Darol K. Froman

Remarks Concluding the Morning Session by Dr. Bradbury

Opening Remarks of Afternoon Session of Conference

by Dr. N. E. Bradbury

What We Propose I by Dr. Frederick Reines

What We Propose II by Dr. R. W. Spence

General Discussion by Members of Conference

\*Editor's note, 1961. Not included in this report because information is in various abstract services of the open literature.

# JULY 19 CONFERENCE REPRESENTATIVES

<u>Representative</u>	<u>Institution</u>
Bonner, T. W.	Rice Institute
Brewster, Ray Q.	University of Kansas
Buchta, J. W.	University of Minnesota
Colby, M. Y.	University of Texas
Dempster, R. R.	Oregon State
Dodson, Richard	C. I. T.
Gingrich, N. S.	University of Missouri
Glockler, George	University of Iowa
Gustavson, R. G.	University of Nebraska
Hughes, A. L.	Washington University
Jacobs, James A.	University of Iowa
Kirkpatrick, Paul	Stanford University
Larsen, H. D.	University of New Mexico
Marvin, H. H.	University of Nebraska
Nielsen, Jens Rud	University of Oklahoma
Pietenpol, W. B.	University of Colorado
Regener, Victor	University of New Mexico
Smith, Sherman	University of New Mexico
Smythe, W. R.	C. I. T.
Stewart, M. A.	University of California
Suttle, John F.	University of New Mexico
Weniger, Willibald	Oregon State
Worcester, P. G.	University of Colorado
Van Atta, C. M.	University of Southern California

JULY 19 CONFERENCE REPRESENTATIVES FROM SITE Y

Dr. N. E. Bradbury	Director
Colonel L. E. Seeman	Associate Director
Clark, J. C.	King, L. D. P.
Conard, D. B., Major	Manley, J. H.
Froman, D. K.	McKibben, J. L.
Graves, Alvin	Metz, Charles
Hall, David	Morrison, Philip
Hill, E. L.	Nicodemus, David
Hoyt, Frank	Reines, Frederick
Jette, E. R.	Richtmeyer, R. D.
Jorgenson, Theodore	Spence, R. W.
Kellogg, J. M. B.	Taschek, Richard
Kelly, Armand	Whipple, Dr. Harry

PROGRAM FOR UNIVERSITY AFFILIATIONS CONFERENCE

19 July 1946

Los Alamos Laboratory, New Mexico

MORNING SCHEDULE

7:00 - 8:00 Fuller Lodge - Breakfast

8:30 Conference Room (B-223)

WELCOME ADDRESS - Dr. N. E. Bradbury

Los Alamos Facilities:

General Description Physics Division - Dr. John Manley

General Description Chemistry Division - Dr. E. R. Jette

10:00 - 12:00 Tour of Laboratory

12:45 - 1:30 Fuller Lodge - Lunch

AFTERNOON SCHEDULE

1:45 - 2:45 Conference Room (B-223)

UNIVERSITY COOPERATION - Dr. N. E. Bradbury

What We Propose - I: Dr. Frederick Reines

What We Propose - II: Dr. R. W. Spence

3:00 - 5:00 General Discussion, guided by Dr. N. E. Bradbury

8:00 Fuller Lodge - Dinner

AFTER DINNER DISCUSSION - Dr. N. E. Bradbury presiding

The Water Boiler: Dr. L. D. P. King

Isotopes and the Water Boiler: Dr. R. W. Spence

Fast Reactor: Dr. Philip Morrison



## OPENING REMARKS

Dr. N. E. Bradbury

As you are probably aware the laboratory has a very definite academic tradition in spite of the fact that we are only about three years old. The entire staff of the laboratory has been drawn almost without exception from the staffs of academic institutions and from their graduate students. This was true when the laboratory was first set up and continues to be true. For many of the personnel here the absence of academic contacts during the war years was a source of regret. The present possibility of establishing such contact with the universities of this region is, therefore, a particularly pleasant prospect for us. I hope that today in the course of this conference we can work out the problems and techniques whereby this cooperation may become a reality.

I would like to start the meeting this morning with a brief resume of the reason Los Alamos exists and what we hope to accomplish both for the laboratory and the universities by this proposed program. Los Alamos was set up to investigate the possibility of creating an atomic bomb. If theoretical and experimental physics showed this to be possible we were to design and construct such a weapon. As you know the weapon was shown to be feasible and it has been constructed. With the termination of the war, the immediate problem of constructing weapons could take a very much lower priority. The laboratory still has, in the absence of international legislation, a definite weapon aspect. Despite this, the emphasis can be shifted somewhat and we can now turn our attention to problems which are more or less fundamental in establishing how and why nuclear energy can be converted into either weapons or power or used in other ways. While our interest in weapons has had to be maintained we, nevertheless, now believe it proper that we so attempt to broaden our understanding of the fundamental physics and chemistry which is involved. For this reason we hope to enlarge our research program in basic nuclear physics and nuclear chemistry. From a certain standpoint of view this is weaponeering. It is well known that the success of this laboratory as well as the success of all other technical laboratories during the course of the war was due in a large measure, if not entirely, to the extraordinary backlog of scientific information and scientists in the country. Without this backlog of techniques, personnel and information it would have been impossible for this country to have carried out the developments so important to victory. We feel quite strongly, therefore, that a laboratory such as this, which at least for the present has a definite place

in the scheme of national defense, must take part not only in a short range program but must also be a part of those activities which have a definite long range aspect. These long range aspects to our thinking include the training of future scientists, the training of technical personnel, the broadening of our basis of understanding of physics and chemistry and the conduct of fundamental research in these fields not only for the immediate benefit of the laboratory but for the benefit of the scientific population of the country at large.

Now the express purposes which we have to foster in the course of this program of university cooperation are as follows. It has been stated, I believe, in the Smythe report, the bible of all security officers, that this laboratory comprises one of the most excellently equipped physics laboratories in the country. I believe this statement is true or very nearly true. In common with other laboratories at this time the necessary return of a large portion of our staff to their academic organizations, to their teaching and to their graduate studies, the laboratory now finds itself in a position in which its facilities are not receiving their widest use. We feel, and I think justifiably, that these facilities which can be devoted to fundamental research should be fully employed in this pursuit. In addition, during the course of the war we have developed here many techniques both instrumental and theoretical which will ultimately be published and be available to the country at large. However, the process of publication is a slow one, it takes time to prepare the necessary manuscripts, it takes time to accomplish the mechanics of publication. We believe that these techniques which can be released at this time should be as widely disseminated as possible and so get into general usage without delay. In general scientists do know these things exist but they do not know how far they have progressed, they don't know the developments which have actually taken place in laboratories such as this.

In addition, we are aware of the fact that university laboratories at the present time are crowded, the staffs of universities are overworked. An enormous number of graduate students have returned to academic universities to complete their graduate work. We believe we can be of assistance in this matter by providing both space and direction for graduate research in physics and chemistry.

Then there is the matter of financing research. I think you are all aware that the present requirements for fairly rapid research in nuclear physics require expenditures of large sums of money for the necessary equipment. Many universities feel that it is impossible, unwise or inexpedient to invest such sums at the present time. The equipment is available here, the funds are available here, and we think we may therefore be of assistance along such lines.

In general we expect that the lines of research which we will carry out here will be in the broad fields of nuclear physics and chemistry. It is quite apparent to anyone who has read the Smythe report that the neutron is the key to the entire atomic energy program. That means to take the case of physics that we are obviously interested in all problems that involve neutrons, encompassing the entire periodic table. Since fission is also involved here it goes without saying that we are interested in the basic problems of fission. We are interested, therefore, in the elements which appear at the upper end of the periodic tables. We hope to be able to obtain here a much more complete understanding of the mechanics of fission than now exists. The fact that the elements at the very low end of the periodic table are known to possess the possibility of nuclear reactions similar to those which take place in the sun, i.e., thermonuclear reactions, indicates we should increase our knowledge of the behavior of these elements just in case there should be something there that we should learn. As far as chemistry is concerned we are of course primarily concerned with the chemistry and radiochemistry of the elements which are of particular interest to this laboratory. These will naturally include the elements at the upper end of the periodic table. There are also metallurgical problems connected with the fabrication of these new elements.

We hope from this program of cooperation that we will, therefore, obtain personnel to work in our laboratory to carry out research problems which we may suggest, which may be suggested to us, which we feel lie in the province of interest to this Project. We may obtain from the universities assistance in the guidance of these students by having members of their staff here to conduct both their own research and to assist in the direction of these students. In this way, we expect to increase the amount of research done by this laboratory which is of interest to this laboratory and to thereby increase our understanding of the basic physics and chemistry problems pertinent to our problems. We hope the universities will acquire from these arrangements additional facilities for the conduct of research in their graduate development. We hope to establish contacts so that they will know what facilities we have here and what problems they may undertake here. We do not propose to go in the undergraduate student business. We propose to give an occasional course on a completely voluntary basis both by our own staff and such members of cooperating university staffs who come here. They will be courses which will be given along lines of our particular problems here, for example, neutron physics; nuclear physics. These courses would treat of certain theoretical and experimental fields in which we here have done a lot of work and in which we hope to do more. These courses will be more appropriate to the three year graduate student and will simply add to his fund of information.

We are not concerned as to whether they actually receive academic credit.

There will obviously be many problems in setting up such an arrangement: security problems, economic problems, theses problems, problems concerned with giving doctorate examination. These are problems we hope to be able to discuss this afternoon so as to arrive at some solution. I am willing to guess at this time that our arrangements will have to be quite flexible, different universities will require different arrangements. I see no essential difficulty in this. The economic problems we will propose to solve by making such graduate students regular staff members of this laboratory employed by us. They would be doing a job we want done, and therefore there is no reason why we should not employ them. This solves several problems and I think it will turn out to be quite attractive to students in question. This afternoon we will discuss among other things the security and declassification problems. I have obviously left unsaid many things which you would probably like to have heard said about the laboratory. However, the program this morning is quite tightly scheduled and I would like therefore, to conclude my remarks on the general purpose of this meeting.

## DESCRIPTION OF PHYSICS DIVISION ACTIVITIES

Dr. John H. Manley

Dr. Bradbury has already told you that Los Alamos has had something to do with the atomic bomb and that in particular there has been a great deal of work done here on neutron physics and nuclear physics. In discussing the work of the P Division I believe that since you will be making a tour of the laboratory later this morning, it will be more profitable to tell you about the facilities and equipment of the Division rather than to tell you about the work from the point of view of the physics problems at hand. I will occasionally, however, mention certain problems so you will be able to get an idea of the nature of the work. The organization of the Division is built up around certain pieces of equipment and this organization is given here together with the names of the individuals in charge of the groups.

Electronics, Mr. Watts  
Water Boiler, Dr. King  
Cockcroft-Walton, Z Bldg., Dr. Jorgensen  
Cockcroft-Walton, U Bldg., Dr. Bretscher  
Fast Reactor, Dr. Morrison  
Van de Graaff,  $2\frac{1}{2}$  Mev, Dr. Taschek  
Van de Graaff, 8 Mev, Dr. McKibben  
Betatron, Dr. Ogle

The electronics group is charged with the responsibility of designing and building all sorts of electronic equipment. One of the chief problems in nuclear physics as you know is the measurement of transients and pulses. Consequently this organization produces many different types of pulse amplifiers, scaling units, and so on, for this purpose. Also there are many problems connected with the measurement of short time intervals, even down to the order of fractions of microseconds. I would like to single out two pieces of equipment to indicate the type of advance that has been made during the course of the war: 1. The voltage analyzer, and 2. The time analyzer. The voltage analyzer will sort pulses into 10 channels according to their magnitude, that is, will sort and record the number of pulses between 2 and 4 volts, 4 and 6 volts, and so on. Therefore, if it is desired to examine the energy distribution of fission fragments in an ionization chamber, 10 points can be taken simultaneously with this equipment, thus decreasing the time of taking data essentially by a factor of 10. Similarly the time analyzer records the number of pulses occurring in a given set of time intervals, for example, the number between 0 and 0.4 microsecond, the number between

0.4 and 0.8 microsecond, and so on. A practical application of this would be the measurement of the reverberation time of neutrons in a large block of material. A burst of neutrons is introduced into the block and a counter, together with the time analyzer, will then show directly the exponential decay of the number of neutrons in the block. It is to be noted that the electronics group is not engaged in standard production work, since physicists and chemists are always requesting unique types of circuits. The electronics group is kept on their toes to meet demands of this nature.

The next item is the water boiler, which is a chain reacting unit with an enriched material. Since Dr. King will tell you more about the actual design of this instrument this evening, I will confine my remarks to the statement that it is a piece of equipment which gives a neutron spectrum from high energy all the way down to thermal energies. The thermal flux is of the order of  $10^7$ . Let me here remark that in the old days a standard neutron source was formed of an appropriate mixture of radium and beryllium. If one takes a curie of radium and mixes it with beryllium one gets a source which gives a flux of the order of  $10^5$  neutrons per second at a distance of one centimeter. One of the interesting things that has been done in connection with the water boiler is to filter the thermal neutrons through additional graphite. The graphite is used to slow down the neutrons and if they are filtered through still more graphite they will be very "cold," actually having a temperature of about  $20^\circ$  Kelvin. There are interesting experiments which have been done in this region of what we call super-cooled neutrons.

It is possible with this reactor to get a total flux of the order of  $10^{11}$ . There is a hole completely through the chain reacting material so that if, for example, very short irradiations are desired at a flux of this order of magnitude it is possible to shoot with an air gun whatever sample is desired through the reactor and catch it on the other side.

In connection with the activities of this water boiler group there is at present under construction a thin lens beta ray spectograph. Not only is it desired to study the beta rays but also to investigate the energies of the gamma rays which are emitted in the straight neutron capture processes.

The two Cockcroft-Walton machines listed are useful in looking at reactions at low accelerator voltages and also as neutron sources. The top voltage of the equipment in Z Building is about 200 kilovolts. This accelerator gives an atomic beam of the order of 20 microamperes. It has been used with the d-d reaction as a neutron source and also to investigate the properties of that particular reaction in that energy region. The other two accelerators have top energies of about 125 kilovolts and of about 50 kilovolts. One experiment I might just mention which would be of interest

as a graduate thesis problem is to study the range energy relation for hydrogen at very low energies. There seems to be no good data in the literature on this low energy region.

The next item is another reactor, the so-called fast reactor. Dr. Morrison will describe this particular neutron source in greater detail this evening. I may remark here that this will be the first reactor which makes use of the new element plutonium and that it will give a neutron flux of the order of  $10^{13}$ ; in other words, something of a factor of 100 larger than the water boiler. It is called a fast reactor not only because it operates quickly, but because its spectrum has a higher neutron energy than the water boiler spectrum. It will be quite a useful piece of equipment since a factor of 100 in intensity is worthwhile having. Experiments on the properties of materials in high radiation densities will be possible. Bombardment by neutron and gamma rays causes structural changes as many of you know.

To turn again to accelerating equipment, the laboratory has one Van de Graaff in operation which gives  $2\frac{1}{2}$  million volts at currents as high as 60 microamperes. This extremely versatile instrument is provided with a precision voltage control good to 1.5 kilovolts. Thus it is possible to get very accurate results. It can be used in the investigation of all types of nuclear reactions within its energy range. It is also useful as a neutron source, particularly with the use of the lithium p-n reaction in which it gives monoenergetic neutrons from a low limit of 5 kilovolts up to the order of a thousand kilovolts. One has considerable flexibility in obtaining neutrons of precise energy in this range. Then of course using the d-d reaction the range can be extended still higher and other reactions will fill in between the lithium p-n and the d-d reaction so that one has essentially a continuously variable neutron source up to the order of 4 or 5 million electron volts.

The second Van de Graaff, which is now under construction, is designed to give 8 million volts according to Dr. McKibben's conservative estimates. It also will have a precision voltage control and will extend the range of operation of the project's Van de Graaff machines.

The project's cyclotron some of you may know as the Harvard cyclotron. It was loaned to this project and arrangements are now under way for its purchase. It will give of the order of 50 microamperes of 10 million volt deuterons. Its use during the war was primarily as a neutron source since our chief lack of knowledge was in the properties of various materials with respect to their reaction to neutrons. One thing which made it extremely useful was its modulation equipment which permits bursts of neutrons from the cyclotron to be sorted according to their velocities, thus again providing

an essentially monoergic neutron source. As one goes to higher energies the resolution of the equipment falls off, but up to about 10 electron volts the examination of the locations of resonances and other phenomena associated with slow neutron processes is possible.

The next item on this list is the betatron which has a top energy of 22 million volts and is used primarily for investigating gamma-n processes.

There are a few auxiliary things in the Physics Division which do not appear on this list and which I would like to mention. For example, we have a remarkable collection of natural radioactive sources. The sources in this category are radium-beryllium, polonium-boron, radium-boron, and so on. We sometimes fail to realize with our wealth of other equipment that even 5 or 8 years ago any laboratory with these natural sources would be extremely well equipped. Also we have a special laboratory for very low counting rates where things can be examined which give pulses of the order of one a month under suitable conditions. There is also a laboratory for the standardization of sources. It is primarily a graphite column and is an extremely valuable piece of equipment for calibrating other sources in terms of a standard or for calibrating detectors.

There is one other activity in which the laboratory has been engaged but which is not at present the responsibility of any particular group, and that is the investigation of various types of ionization particle detectors. There is still a great deal of work to be done along these lines in spite of the progress made during the war and it should be a fruitful field of work for graduate students.

I think Dr. Richtmyer of the Theoretical Division would like me to say a word about the physical equipment of that Division. In addition to ordinary calculating machines it is equipped with a complete set of International Business Machines which are used in connection with complicated calculations.



## ACTIVITIES OF CMR DIVISION

Dr. Eric R. Jette

The work in the Chemistry and Metallurgy Division is organized rather differently from that in the Physics Divisions. It is organized around material rather than around equipment. We have a very well equipped laboratory here and we have or can get any standard manufactured equipment that exists on the market. In addition, we can make a great deal of equipment of a special nature that we need.

The Division is concerned with the handling of rather large quantities of radioactive or fissionable materials except on one branch that I will mention later. We are in general not interested in any problem that can be handled only on the microgram or even on the milligram scale. The necessity for handling large quantities of such materials - for example, all the plutonium ever made has passed through Los Alamos - gives rise to many problems. The element polonium is one of the nastiest to handle and that raises some very special problems concerning the protection of personnel. For that reason we have had to develop a good bit of laboratory furniture to protect the workers from the contaminated dust. In view of this, practically all our experiments are done in closed systems. You will see some of these when you tour D-Building. You will see boxes having glass fronts with arm holes fitted with heavy gloves in which the men reach in to work.

One of the many things we have to study is the chemistry of plutonium. There has been a great deal of work done at Clinton, Berkeley, and Chicago on the chemistry of plutonium. The difference between the work done at those places and here is largely one of scale. While they work with milligram quantities as a maximum, we work well up in the gram scale. This enables us to study many of the chemical reactions in a much more thorough-going fashion than is possible at the other laboratories.

So far, our main efforts have been devoted to studying those reactions which are of interest in the production of plutonium. We have also gone into the study of uranium reactions, but because the uranium is an old and well known element and working with it does not involve the health hazards that plutonium does, we haven't done much work on its chemistry. There is still very much to be done in the study of the chemical reactions and the preparation of plutonium compounds. The physical chemistry of the reactions is particularly important. The reactions are complicated by the existence of several oxidation states, and the conversion from one state to another

is very frequently complicated by rate phenomena. The ordinary kind of data one needs for production purposes which are also basic chemistry, such as oxidation reduction potentials, solubilities of other materials and the plutonium salts under conditions where solutions contain large quantities of other materials have been worked up to the point where we can handle our production problems but we still don't understand the reactions very well. It is one of the objectives of the division to get our knowledge to the point where we understand what we are doing.

Another element worked with here is polonium, and there are very many chemical problems involved with that. There again we handle larger amounts of the material than has been possible in the past. Although gram-wise they are still trivial, energy-wise they are somewhat fearsome. Again special techniques have had to be developed, and we have gotten to the point where we do what we are supposed to do without knowing too well why those operations work. Polonium chemistry is almost a wide open field and polonium chemistry is one of the things we hope to go after rather actively.

The third field is one of radiochemistry. Here again the laboratory is able to secure radioactive materials -- it has access to many isotopes and radioactive material that ordinary laboratories don't get very easily, and we have the use of some of the physics equipment such as the cyclotron and water boiler to make certain of these materials. This radio-chemistry is essentially tracer work and we are equipped with the necessary counters, etc. This is a field which has been pushed along rather sporadically: at times we have needed some techniques and results and then the work has been pushed. But now the laboratory plans are to get into these fields rather steadily. Radiochemistry as it is at the present time is a relatively new field. The old men in it in this country have been in the game only 5 or 6 years longer than the young men. There are very few places where training is given. We expect to be able to train men and give them experience in working on the tracer scale with fissionable materials. Now there are a few other things we are very much concerned with. The physical properties of some of these elements such as plutonium and polonium, for example. We are now in the process of determining such characteristics of plutonium as heat capacities and thermal conductivities. Electrical conductivities and magnetic properties will be studied later on. In general, we will have to produce here a complete table of quantitative values for the various properties. The same is being done in so far as is possible with polonium. One of the jobs we have recently completed was the determination of the crystal structure of metallic polonium.

In the metallurgical work, the physical and mechanical properties as

well as the structure of the alloys will have to be determined. As I mentioned before, the equipment we have for this type of work is not particularly exciting in the same sense that the water boiler is exciting. We have spectroscopes, x-ray diffraction equipment, and electrical instruments, and all of the usual chemical equipment. We go in a great deal for high vacuum work, and we have a great many high vacuum installations with relatively high capacity.

One of the developments was in the field of analysis where methods were developed for determining carbon and oxygen in very small samples in spite of the fact that the contents of these impurities were running in a few ppm. In work in analytical chemistry our analytical methods on plutonium and uranium are not in too good a shape, and there are very many problems along that line.

While we have a good deal of metallurgical equipment, there is nothing unusual about that equipment. Any good metallurgical department has about the same sort of equipment. We don't undertake here systematic or long-range investigations on just any alloy system that one might think of. We try to get other universities and laboratories to handle most of the problems. The problems that require special handling and special techniques characteristic of the work on plutonium are the kinds we handle here. For example, if someone wanted work done on the gold-plutonium system, we would certainly want to do it here as we have the protective measures and techniques necessary to handle it. But on the other hand, work on gold-beryllium system we would probably try to get another institution to handle.

To indicate the types of problems in metallurgy in which we are interested and in which we are prepared to carry graduate students, there are metallurgical problems in the study of physical and mechanical structure, and phase relations of plutonium alloys. We are also interested in the study of the thermodynamics of many of these plutonium reactions. These include not only reactions that take place in solution but also a number of high temperature reactions involving reactions with refractories, the gas-solid type of reactions for making anhydrous compounds, and that sort of thing. Thermodynamics questions include a very wide range of problems including such matters as electrical potentials, solubilities, activity coefficients and the like. We are very much interested in rate phenomena because they are very definitely important in our production plant and in addition have scientific importance. The particular reactions we are first interested in are those that are involved in the production plant. That doesn't lessen their intrinsic interest. We had to pick a starting point and we picked that one.

In analytical chemistry, as I have said, there are quite a number of

problems. We are able to handle radioactive materials here and we can work quite safely with them. The whole laboratory has been built around the handling of that kind of material and these, plus the availability of such materials constitute the most unique features in the work of the chemistry and metallurgy division.

## ACTIVITIES OF M DIVISION

Dr. Darol K. Froman

As Dr. Bradbury said, the name of this division is the Experimental Physics Division. It isn't implied by that name that other divisions such as the Physics Division do not do experimental work -- in fact, a great deal is done in chemistry and physics, and we have no corner on the experimental research done at Los Alamos.

Incidentally, it may be that during the day you will hear some explosions, and don't be startled if you do. There is a certain amount of HE (High Explosive) in the neighborhood of this laboratory, and work that goes on with explosives is carried on a considerable distance from these buildings from the point of view of safety.

It turns out that there have been quite a number of techniques developed or improved for the study of phenomena connected with high pressure and high temperature -- namely, those things in connection with explosives. There is at Los Alamos an Explosives Division which is represented at this meeting by Dr. J. C. Clark, Associate Division Leader. Dr. Max Roy, the Division Leader, is unable to attend at this time. The Explosives Division and the so-called Experimental Division have quite a number of techniques which were worked out for the study of physical phenomena apart from the fields of nuclear physics. Since partly because of the lack of time you won't be visiting the laboratories of these Divisions at which this work is going on, I would like to mention the sort of apparatus at our disposal. We have high time resolution measuring equipment such as flash X-ray techniques, flash gamma ray techniques for taking photographs in the microsecond region, flash photography in the same region, and electrical contact magnetic methods. In addition we make use of piezo-electric crystals and so on for measuring the motions of material impelled at high velocity, the pressure involved therein and such quantities. It is quite feasible to measure material of shock velocity of the order of 20,000 to 40,000 meters per second in distances of a few millimeters with a precision of 1 percent. This means that the timing equipment for measuring a displacement time curve is good under fair conditions to a hundredth of a microsecond and under best conditions can probably be pushed to a few thousandths of a microsecond.

Various interesting phenomena arise which are associated with these high velocities. If, for example, you excite a shock in most gases they become luminescent and the spectra of shock induced luminescence is an interesting subject about which a great deal is not known. I think this is one

of the fields in which we might interest some graduate students. Again, the subject of making nuclear physics measurements on the very light elements has been mentioned. It is conceivable that the high velocities obtainable in this field of physics might produce motions of materials of such high temperature that we could produce thermonuclear reactions mechanically. If this is so it should become a field of considerable interest to this laboratory. Since you unfortunately won't be seeing this equipment, I didn't want you to go away without having some idea of it. This unique field is a difficult one to investigate in most universities because of the geographical location.

Dr. Bradbury comments on the above statement:

I would like to add to Dr. Froman's statement that the field of research which has been discussed, namely those fields which have to do with the propagation of shock in metals, the mechanisms of shock, mechanisms of detonation of HE, are fields which have a great deal of interest to us but, of course, are not widely known and are not generally studied at an ordinary university. These are fields of research which pertain in considerable measure to classical physics and are intimately related to the equations of state of materials under very extraordinary conditions of pressure and temperature. These classical problems have been approached with quite modern techniques and provide experimental fields which represent another aspect of the laboratory's work which I think should prove to be of great interest.

## REMARKS CONCLUDING THE MORNING SESSION

Dr. N. E. Bradbury

We have endeavored to describe for you in a brief and rather sketchy fashion the activities of the laboratory in which we believe graduate research could be done by graduate students. This had to be sketchy and incomplete in view of the fact that the present employees of the technical area in which this work is done number over a thousand. The presentation you have heard this morning has of necessity covered the general ground.

I would like to conclude the meeting this morning with a few observations as to the general philosophy of the laboratory in connection with this proposed program. As has been described to you, there are two possible ways in which a given experiment might be undertaken here by a graduate student. One would be for us to suggest an experiment directly to the man, or to the university or to the department, and another would be for the university or the department to suggest a man and an experiment. In the latter case we would get together and decide if it is an experiment which falls in the normal field of activities of this laboratory as described this morning. I think you will have gathered from what has been said that in the fields of basic chemistry of the fissionable materials, and basic nuclear physics, our interest can be and will be quite broad. We don't claim in any way to have a unique monopoly of the bright ideas for experiments in these fields. We hope and expect that there will be suggestions made to us for jobs which we like, for which we have the equipment, and for which a man is suggested to carry them out. I wish the impression to be quite clear that we are not suggesting that the experiments would be dictated by this laboratory. Yet, for purely practical reasons which primarily involve the expenditures of government funds, the experiments which are carried out here will have to be experiments which the laboratory approves. The laboratory will approve experiments which fall in the general fields of the work described here. I am trying to make the base of this pyramid of knowledge as broad as possible. I believe we can look with favor and interest on a wide variety of experiments which fall in the general outline of the work which has been described.

I am sure also that many of you will be concerned as to the general philosophy of the publication of results as it exists at present. We will go into more detail this afternoon. I merely want to mention this morning that the Manhattan District has adopted the point of view which was presented to it in the so-called Tolman report. This is a declassification guide or report

prepared by Drs. Richard Tolman, J R. Oppenheimer and R. F. Bacher and others which recommended an order of release of the scientific research done by the various Manhattan District projects. The Manhattan District then secured the approval of the President of the United States to carry out the declassification. I think it is not generally known that the security which was imposed on the Manhattan District and for which it has been very frequently and widely criticized was not the choice of the Manhattan District but was imposed on it by presidential authority and it was necessary to secure the presidential authority to release the material on work done by the Manhattan District.

This declassification program is now under way and we are at the present time releasing scientific articles at a considerable rate. When I left for Bikini several weeks ago there were at Los Alamos something of the order of 100 articles or documents undergoing the declassification process. It is becoming a formidable task as to the point of view of the character of the work associated with it. The declassification guide at the present time allows the release of the details of instrumental techniques, a large variety of fundamental physics and chemistry dealing with all the elements except those which are exclusively involved or have some particular interest in the construction of the weapon. The fundamental physics of some of these elements such as plutonium will probably be reserved for release at a somewhat later date. The actual techniques of how to make an atomic bomb will be, I presume, one of the last things which will be revealed.

I want to make it clear that the process of declassification and the release of scientific information is going on now and I have every reason to believe will continue at an accelerated rate. This will, of course, depend somewhat on the character of legislation which is at present pending in Congress. The background work is already done.

The progress of physics is dependent upon a free interchange of basic nuclear physics data. Yet even without this free interchange I think some spread of knowledge is bound to occur by the process of diffusion if nothing else, and to attempt to stem this particular tide is quite futile. Since it will happen in one way or another, well it is that it is happening now in an orderly way; the things which are most obviously declassifiable are being released now and the things about which there are questions will be released a little later on and so on. Now the question of what would happen to a thesis or a piece of work done here by a graduate student we will discuss in more detail this afternoon. At the present time we must recognize that work in some fields would be releasable and publishable immediately, but that others might have a higher classification and not be released for some time. I wish you to understand that this problem is, in general, being



handled in a reasonable and logical way.

Another word about the philosophy of the laboratory in so far as it concerns the actual construction of an atomic bomb. The principle has always been to avoid what might be called compartmentalization. All members of the laboratory staff (a man with a BS degree or better in science) have essentially complete access to all information. Even during the early career of the Project there was a very definite widespread knowledge among staff members of what was going on. I would like to continue this. It is, therefore, desirable that the graduate student doing a research problem in physics or chemistry be a member of the laboratory's regular staff as an employee. This, of course, means that he must undergo the ordinary security investigation: a graduate student comes here, he would simply be a member of the laboratory along with everyone else. The only difference is that he would not be subject to diversion from his thesis activity. In other words, if an emergency arises where we would have to have some job done, the graduate student on this basis could not be taken off his thesis and put on some laboratory work. We will have to assume, then, that the graduate students are members of the laboratory staff. They will not be deliberately lectured on how to make an atomic bomb, nor will their ordinary work lead them into contact with matters of bomb operation and design, nor will they be encouraged to find out these things. But there will be no outside restraint put upon their activities, and I think it inevitable they will find out in a general way what makes an atomic bomb tick. They will then, of course, be subject to the ordinary security restrictions about discussing this, and since they will be reasonable people and discreet, this will be no source for concern.

This afternoon we will go into more detail on what we propose as a starting point for this program of cooperation. Undoubtedly, as I have said before, there will be things which we will not have thought of, there will be problems which you will point out, but we will make a certain general proposal as a starting point.

## AFTERNOON SESSION

### OPENING REMARKS

...Dr. Bradbury

We will now hear from two members of the Los Alamos staff what we propose along the lines of university cooperation. I would like to emphasize that the mechanism of affiliation will have to be extremely flexible. It will have to take care of a wide number of different university policies, it will have to take care of individual requirements, and I see no reason why this cannot be worked out.

## WHAT WE PROPOSE I

Dr. Frederick Reines

The brief talks that Dr. Spence and I are going to give now are for the purpose of indicating the sort of thing we have considered and to provide a starting point for the discussions. After all, the real reason why we are here is to see what you think about all this and to learn from you what changes in our ideas are necessary in order for us to make this a practical arrangement.

The first item of interest is the scope of this plan. We are interested in supplementing and assisting with the training of graduate students. We are not interested, as Dr. Bradbury clearly pointed out, in competing with universities. This is not the idea at all. We would perhaps take students who had a BS degree plus two years of experience in graduate studies to do their research here. There might be courses in specialized topics -- say nuclear physics, neutron physics, radiochemistry, and the chemistry of the heavy elements. We are not going into the business of educating in a formal way, and we recognize that it is entirely the university's obligation to take care of the matter of accrediting courses and accepting theses and so on. We do have staff members here with the proper qualifications to teach these various special courses, but we do not intend to carry on a full fledged graduate teaching program.

The main purpose of the student's coming here would be to do his thesis research. This naturally brings up the problem of who suggests the research and then who guides it. It might be that the problem is initiated by a member of the Los Alamos staff. He might say that there is a research problem which takes about a year, for which he would like to find a willing graduate student. He then makes the suggestion to the university by whatever formal procedures are adopted. On the other hand, if people from universities are aware of the sort of fundamental research going on at Los Alamos, they might have some idea and suggest it and a student whom they think is suitable to work on it. There is only one catch -- if you want to call it a catch -- and that is the problem has to be of some interest to the laboratory. It is pretty hard to find things that aren't of interest to the laboratory if you stay in these general fields. One can't quite tell in advance, but if it is in nuclear physics or radio-chemistry we are probably interested, although the division of the laboratory in whose province the problem lies would be called upon to decide in each case.

The next question is the status of the student at Los Alamos. Certainly the student would be recognized as such, and academically would be under the jurisdiction of the university. He would, in actuality, have a sort of dual role, and this perhaps might make things a little difficult. As far as the university is concerned, they would recommend a specific man for such a fellowship to a committee which is set up here. Then after the man has been cleared it is decided whether or not he is one of the better students.

In starting we would set an upper limit on the number of students we would accept, say perhaps 15. This number is not to be taken as fixed. It depends first of all on whether the student is in existence; it may be that there are no students to come to Los Alamos this fall. It depends on whether the students that would like to come are considered to be properly qualified by the university, whether they can get clearance, whether there are problems on which a student cares to work. One has to settle all these things. One would hope to start out on a very modest scale so we can learn about the problems which we may expect to encounter in connection with such an arrangement.

So far as the university is concerned, we might call this man a Fellow. As far as Los Alamos is concerned he would be an employee, a regular member of the laboratory staff. He would receive the customary clearance and so would have access to all documents regardless of classification.

We are very anxious that the student be treated as a member of the staff but also that he not be simply taken off his thesis research as can other staff members to do other things which are of interest to the laboratory but which don't concern his thesis work. Actually one should not draw too much of a hard and fast line in this direction because students receive much of their training by working in groups with other people on other things. They might as a result of their group activities get their names on their own theses and perhaps get their names along with several others on something else. It is certainly a good idea for them to work on a few machines in order to get experience. However, it is our intention that he would not be taken away from his research to do some job which wouldn't be of direct value in his graduate training. If he wishes to depart from strictly thesis activities it would have to be with mutual consent of the local advisor and the student. This is to make sure he is a student and not a member of the staff hired through the university to work at Los Alamos exclusively for our own use.

Now of course it is desirable to make these things attractive so we can get fifteen or so good men from the affiliated universities. To get good men and relieve them of economic stress we feel that they should be properly

treated economically. The present salary range for a member of the laboratory who has a BS plus two years is from \$250 to \$300 a month. In view of the fact that this man is getting special consideration, one might wonder about invoking the higher end of this scale. Perhaps one might set the lower limit at \$200 a month. This is below the minimum scale for a BS plus two years, but just how much the student receives is a matter for discussion. One should probably make an allowance -- say \$50 per month, for the married student.

Then there is the question of another possible student classification. The idea is that there are people at Los Alamos who have a BS plus two years who are good men and who would like to go back to universities to finish the requirements for the PhD. This is certainly to be encouraged, but it does lose us trained men. Now if this man had a PhD he might be interested in coming back to Los Alamos to work. From our point of view, it would be good to have those men come under the sort of plans we are discussing. As far as the university is concerned, they would be treated as an ordinary student who sought a fellowship. As far as Los Alamos is concerned, they could get a leave of absence to go take their course and then come back to Los Alamos as employees to do their research. The university would first have to agree to take this man on as a student. All these are suggestions, and how they are to be carried out is a matter for much discussion.

Another interesting question is the status of faculty members of universities with respect to this plan -- how, for example, they might guide their students. Perhaps the university will not send a man here full time, but they nevertheless will want its faculty to guide him personally. They might serve as consultants and be really responsible for the work but appoint a person here to guide the day-to-day activities of the student. There are classification and security problems which Dr. Spence will discuss in this connection. The supposition in this is always that what is being done is of interest to the laboratory because it is the laboratory's work which is being done and it is of interest to the university because they are training a graduate student who is going to get a degree from that university. Another possibility is that the member of the faculty goes on leave and comes to Los Alamos for a year or for shorter period of time such as the summer. These are some of the possibilities as we see it. Of course each appointment would be treated individually. Another possibility would be the exchange between Los Alamos and the affiliated university of men of similar caliber. I would like to close my remarks with another comment on the question of guidance. It might be the university which is affiliated sends a student here but has no one to guide him. However, it may be that they

are perfectly satisfied as to the qualification of the members of the Los Alamos staff and are perfectly satisfied to have a member of the Los Alamos staff to guide the student. It might simplify matters if the member of the Los Alamos staff were appointed a member without pay of the particular university but residing at Los Alamos.

These are some of the general ideas we have on the subject of university affiliation. Dr. Spence will now discuss some of the problems associated with this plan.

## WHAT WE PROPOSE II

Dr. R. W. Spence

Dr. Reines has given a sketch of the proposed plan for university affiliation. I would like to discuss briefly some of the possible problems that will arise under this plan.

The first concerns classified material and its use by a student for thesis material. Under the suggested plan, the students will be cleared and we should expect no difficulty so far as the students are concerned. Faculty members of universities who are consultants or who come here on leave of absence or part-time during the summer will also be cleared. Difficulties will usually arise in connection with thesis material and examinations, and I will shortly propose ways of meeting these difficulties. The subject matter which is declassified is now in a state of flux; more and more material is being cleared. The items on the sheet which I passed out show material which has been declassified at the present time. We can expect a much wider range of subjects to be cleared in the future.

Thesis subjects may or may not be classified. Some will clearly not be classified and so no particular difficulty arises. Others will be clearly classified, while still others will be borderline cases, and at the beginning of a research it will not be clear as to whether they will become classified or not. At any rate, it would be advantageous if at each university some plan could be worked out to handle classified theses. This becomes particularly true for the doctorate examination. Let us suppose that the thesis material is classified; the question comes up about the candidate's doctorate examination. Often such an examination consists of two parts; examination on thesis material itself and then an examination of the competence of the graduate student in the general field in which he has worked. It is quite possible that it can be arranged for a sub-committee to be formed of people who are cleared for the thesis material and that the examination on the thesis work be given by such a cleared sub-committee; the examination on the general field in which the student is working can be given by the regular examination board in the usual university fashion. The cleared sub-committee might be made up of faculty members who serve as consultants to the Los Alamos Laboratory or faculty members who have come to Los Alamos for part-time work or on leaves of absence, or Los Alamos staff members who have been approved by the university, or a combination of all such cleared people. I believe that problems concerning the doctorate examination can be worked out with each university although the same plan may not work in each individual case.

The second question concerns the publication of classified work. Publication within the Manhattan Project is assured; the work can very well be written up as an ordinary project report. Publication outside the project will be withheld until the material can be declassified. It is possible that in some cases a declassified abstract can be written which will satisfy university requirements regarding abstracts of theses. There may be cases where no such abstract can be written, but it is a possibility.

There are certain university requirements which of course are primarily the concern of the university only -- the question of fees for the graduate students, residence credit, provision for graduate work in absentia. Obviously for such a plan as we have outlined to work, each university must be willing to let the graduate student work in absentia for a year. There will be certain problems which each university will have which have not been covered but which I hope will be brought out in the discussion.

Another point has been raised about individual versus group research. Generally speaking, the fields of nuclear physics and chemistry involve cooperative effort. That is to say, a person doesn't do all the work on a Van de Graaff, such as keeping it running and in order and do his research work at the same time. I think we will have to recognize in this field that a certain amount of cooperative or group research is inevitable, but we do not propose that the work which a graduate student does be group research. The student will be primarily responsible for his own problem. If a student works on the Van de Graaff, for example, other members of the laboratory also using this machine will cooperate with him in certain phases of the work, especially those concerned with the running of the instrument. He may lend a helping hand in some types of investigation and in return he probably will receive such cooperation, but I don't believe it has ever been proposed that the research would be of such character that the graduate student would not himself be primarily responsible for his own thesis and the bulk of the work connected with it. He must still gain in his graduate work the usual amount of competence and independence in his thinking and in his work that would be required at any university.

Another problem in which you may be interested is how many students we can actually accommodate here. I can only speak in general numbers. A survey of the laboratory, its facilities and men qualified to handle graduate students would indicate that we could probably handle 15 to 25 all told. This is in physics and chemistry both. Roughly, the proportion is about equally divided between physics and chemistry, but slightly lower in chemistry. This is about the total amount we guess we could handle, although no definite figure can be put down.



I think you will see that most of the individual difficulties are those which concern either classified material and special ways to get around the concomitant problems, or difficulties of adequate supervision of the students to the satisfaction of the university staff. It is quite possible that a university staff member has a problem, a man in mind to work on it, and would like the work on the problem done at Los Alamos but he himself not have enough time to come here to supervise the research student. I believe that some satisfactory arrangement could be worked out so that periodic visits to Los Alamos could solve the problem. The direct supervision might be delegated to a Los Alamos staff member, and the faculty member who proposed the problem, or who is primarily interested in the problem at the university could come here to check the progress of the student and discuss the problem just as if he were a regular consultant on this project. I think this arrangement could very well work out. I think it would be preferable from all points of view if the faculty member could be here on a year's leave of absence and guide the student in a direct fashion, but we are anticipating in the next few years that a shortage of scientific personnel will make this a very difficult thing; that it will not be possible for a university staff member to leave his university for a year to come here and work. During this interim time we had hoped that some delegation of supervision could be worked out with qualified Los Alamos staff members.

## GENERAL DISCUSSION

Dr. Bradbury: May I summarize the remarks which Dr. Spence and Dr. Reines have made and indicate, in a schematic way, how the problem looks to us at this time? This may serve as the starting point of the subsequent discussion.

As things now seem to us, the procedure might be something as follows: we would be the recipient of a letter from a graduate dean or head of a department, saying that he had a man of certain qualifications. The man might have the subject on which he would like to work for his thesis, or there might be more than one man of this nature. There might, in addition, be a staff member who would want to come along to supervise the research. At any rate, we would be made aware of an individual, or individuals, with or without specific problems, and with or without various amounts of direction from the university proposing the man.

The first thing we would then do would be to examine the qualifications of the man; see how he compared with others who might be presented, see to what extent we were able to absorb this particular man, and the problem, if any, that was suggested. If the problem seems to fall in our province, and is one which we would like to have worked on, and the background and recommendation of the man seem to indicate he is the type we would like to have here, we would then at once proceed to have the man cleared. This is a province of security -- G-2, if you wish. Clearance of an individual generally consists of looking into the background of the person concerned; where he was born, where his parents were born, what type of work he has been doing, his reputation -- does he drink? is he discreet? who are his friends? with whom does he associate? is he a campus radical? is he a soap-box orator? etc. These are not necessarily against a man, but, in a general way, security wants to know what kind of a man is this. In other words, if he knows something, can he be trusted to keep it to himself? In only an almost infinitesimal percentage of cases do we run into security difficulties. Once in a while we find a man who, for some reason, cannot be cleared. Generally speaking, it turns out to be somebody who has announced in public that he is not in sympathy with the United States Government, or something of this sort. Since this is a government project, and the government is the employer, in the last analysis it has to be satisfied with people it takes on. However, this refusal of clearance is something which occurs very rarely, and I don't anticipate any difficulty. It is something which takes a matter of from four to six weeks to carry through, depending on how many places he has lived, what he has been doing, and how far the investigation has to be carried through.

Let us assume the investigation shows the man is cleared. We then request the man to come here for an interview so that we can see him, and he us. This, in fact, could be conducted at our expense, and would be called a pre-employment interview. Our project employment policy provides for us to pay this expense. The same thing would, of course, be true relative to any university faculty member we would sign up as a consultant, who might be responsible for the research that was to be carried out.

Let us assume that all interviews work out to everyone's satisfaction; the man is employed and starts to work. Initially he would be placed as a member of some active group; he would have a certain period of training, learning where things are located, techniques, etc., which would take from one, two or three months, and would be characteristic of any new man starting in a new department. He would have to find out the mechanics of carrying on the work here. He would be required to learn the operation of the Cyclotron and Van de Graaff. This would occupy only a part of his time and his particular job would be his particular responsibility, although he would contribute and learn techniques of other jobs going on simultaneously in the laboratory.

We do believe that a man should be able to accomplish a reasonable graduate thesis in about a year's time, probably from nine to fourteen months. But, if the problem assigned to a man should reasonably be accomplished in a year, and is not, then either it is too hard, or the man is not capable, and we ask him to terminate. We do expect to assign problems which could be accomplished in about that time, although we would be glad to have this particular point discussed.

Then, we would give an occasional course, but whether these courses were accredited would not be a matter of concern locally, although it might be of concern to the man. On this account we would make an effort to see that courses were accredited. We would be primarily concerned with the operation of the student here, in his rapid indoctrination and training in the particular work we do, and in adding to the general knowledge of students who might be working in other fields. This instruction would probably be done out of hours.

Salary arrangements would be made on a basis which would depend on the man's background, his family responsibilities, and things of that sort.

Having concluded his research to our satisfaction, and to the satisfaction of any faculty representatives, or direction from his own university, the thesis will be prepared. What happens to the thesis will depend upon the classification of the thesis; if it were a declassifiable thesis there would be no reason

why the thesis should not be returned to the university to be read by the university committee; if it were a classifiable thesis, one which could not be read by everyone, then there are various clearance possibilities which would have to be looked into for a solution. One possibility used in the past is for me to appoint a local committee containing, if possible, representatives of the university in question who happen to be on our current staff. This committee might be consultants from the university in question. This committee then reads the thesis, and reports upon it to me. I inform the university of the general field and general title of the thesis, and names and academic affiliations of the committee reading the thesis, and the report of the committee upon the thesis. This particular arrangement has been used and proven to be satisfactory for several universities at the present time; otherwise it may be necessary to establish consultant members to this laboratory from the university in question. These would be staff members of this laboratory on a consultant basis, and thereby cleared to read material on this particular thesis. They would then report to their university what they considered to be the character of the work. The student's academic requirements, other than the thesis, we would have to leave entirely up to the university. These matters are the province of each individual university, except when we come to the question of what to do about examining the man on a classified thesis. Various methods have been suggested as to how it might be carried out. It may be that the reading of the thesis will be sufficient; it may be the qualified committee can be set up to read the thesis; and it may be that the examination can be conducted so that the specific numbers to which the classified thesis would refer would not have to come into the examination.

I suspect, in this particular circumstance, we are possibly making a mountain out of a molehill, and that this may turn out to be an easier problem than we see here.

If the thesis is classified, then it becomes a Manhattan publication and a certain number of copies are printed locally and distributed in accordance with the rules of the Manhattan District; but until they are declassified they could not leave the Manhattan District. If the material should, in the course of time, become declassifiable, we would declassify it and notify the man and his university, and if the man wanted it published he would put it into publication form, but this will take longer. I think the only thing we would request is that somewhere in his published material the man specify the work was done in Los Alamos; but the present residence of the man would be given as his residence. In other words we also would like to get credit outside for doing some of these jobs.

I think that is about the situation, as we see it. Admittedly there are problems that we haven't made clear. If so, these are the questions we would like to have brought up now.

Dr. Stewart (U. of Cal.): I think probably the University of California has thought as much about this type of problem with which we are faced here as any other university in the country and I think, Dr. Bradbury, it might help in crystallizing the discussion, if I could speak as a graduate dean because, after all, as one of those unfortunate persons, I see certain difficulties which, at least, our faculty would not see unless pointed out to them.

I think every university will admit, immediately, and without any reservations, that the talents of the staff here, and the type of facilities for research which can be done, are not equalled anywhere. But the problem of doing graduate work away from a university unfortunately is not so simple as to say that with the distinguished staff, and with almost incredible facilities, all questions are answered.

The first problem that occurs to me, and I want to make it clear that I am not speaking against this proposition, is that any university awarding a degree is obviously awarding that degree for work done at the university in question, under the supervision of appropriate members of its faculty, in accordance to its own individual regulations and restrictions. Now, that is almost as formidable as it sounds. In other words, there must be very strict control on the part of the university of all graduate work. It isn't going to be simple for the university to say Los Alamos is the one place where it can be done. We are going to have for consideration comparable propositions from Naval Ordnance, for example, and other agencies. We are going to have to be very careful that our graduate work doesn't become, more or less, of correspondence course caliber, and we're going to have to be particularly careful to maintain the distinctions between an earned degree and an honorary degree. As a matter of fact, it is quite possible that some of the work that has been done and is and will be done, is work which justifies an honorary degree and a meaningful honorary degree. But it isn't necessarily so that because it is work of value that it can be recognized in partial fulfillment of the requirements of an earned degree. I bring that point up first because I'm sure the graduate deans of your respective universities will think in much the same distorted fashion as I am thinking, because that's a disease of all deans. We become glorified policemen despite our good intentions.

Now, you see, that leads logically to a question already presented here, namely, the matter of appointment of an individual who is going to personally supervise the work that is being done. I know of no university that will

permit its students to work elsewhere in another university, e.g., and get credit in its university for work done there, regardless of the reputation of the university in which the work is being done. The degree represents the university that awarded it, and I am quite certain that my graduate council would not consent for a moment to recognize thesis work, regardless of the excellence of the man under whom it was done unless it was done under one of our own faculty members. We have not had the problem to face in the past with reference to thesis work done at Los Alamos, because at least one of our men was here a good part of the time; but that's an important point.

The suggestion has been made by Dr. Bradbury, and it is a suggestion that deserves thought, that a staff member of this laboratory might be appointed as a research professor. If that could be done it would answer one of our problems, but, as most of us know, it is frequently difficult enough to get a new appointment for a man who is going to be a regular professor in residence, to say nothing of a research professor not in residence. I think, however, that it is really well worth full consideration.

The matter of residence was raised. I am inclined to think that possibly that point has been over-emphasized by the men of the staff here. All of us have a certain minimum residence requirement that must be fulfilled. You have already stated that your idea is that a man will have two years of residence as a graduate student before he comes here. That's going to put him in pretty good shape if that student is the type of man you want. He should have about finished his course work, he should have completed his departmental and qualifying examinations. I think you would probably want to make that a requirement for a man coming, and that is not an unreasonable requirement. At the University of California we require a year of residence and candidacy, which is a common requirement; that is to say, a man is elevated to candidacy after passing his qualifying examination. The problem of satisfying the residence requirement is not a very serious problem. If a man could come here and do research leading to his dissertation in the period of one year, he would not be penalized at all by returning to his university for a year, during which time he might be analyzing the data he had collected here, or doing other work. There may be difficulties, of course, with respect to security in that particular matter, but I do feel that, with our students in physics and chemistry, at least to the University of California, such students would have to return to the university for one year.

We have had other requests from students who have been doing work in Naval Ordnance. In several instances, with a considerable degree of reluctance, we have accepted, as thesis, classified material. Now, there were particular circumstances accompanying these special dispensations. In each

instance there was a regular faculty member of the university at the place where the work had been done and this faculty member was closely connected with, if not actually directing, the research in question. Each of these students proved to be exceptionally good, and furthermore we felt rather sympathetic to them because of their contributions to the nation in time of war, and because their regular program of graduate studies had been interrupted by the war emergency. I mention that because possibly our council was a little more lenient than it will be in the future. We had no difficulty with the committees to examine the thesis because in each one of these instances upon which we acted favorably, we had an adequate number of faculty members who were privileged to examine thesis material.

Of course we did meet with some objections because we rather sanctified, possibly, our regulation that the two copies of the thesis must be duly filed in the library of the university and that there must be the usual number of abstracts, which I'm sure no one reads but the student himself. The matter of classification of material, it seems to me, at least so far as the University of California is concerned, would present as a special problem the matter of filing the copies of the thesis in the library. I am quite convinced, however, that at least for several years to come, we shall have members of our faculty who are permitted to examine thesis material and to examine the students orally upon such matters.

Now, I had several questions in mind to ask, after I knew of the conference. Some of these have been answered already; however, one of the major questions in my mind is: whether the graduate student would be a glorified Diener, or whether he would be an investigator of the type we normally expect of students working for a doctorate. I believe it has been stated twice that a graduate student here would be expected to demonstrate the initiative, the independence of thought, and the independent analysis with appropriate direction and criticism that we would expect if his work was done in a university.

Another question is this: the cost consequent upon a faculty member who had been appointed as consultant coming here at frequent intervals to check up on his student?

It was my understanding there would be provisions to take care of that faculty member's travel costs. There is, of course, connected with it another problem that the professor himself might present, namely: the amount of time required for the supervision of a single student. He might feel that he did not have time to devote to travel. That would be up to the individual professor, in most instances. I might say, in connection with this, that the leaves of absence for faculty members to come here for a semester, or

year, is, I believe, going to be somewhat more difficult in the next few years than it has been in the past. Administrative officers of the universities are a little bit tired of receiving requests for a leave of absence, and they're showing greater reluctance to meet those requests. This reluctance is strengthened by the fact that the number of students is increasing alarmingly, and that is particularly true in departments of physics and chemistry. As a graduate dean I'm almost convinced that everybody wants to do graduate work in chemistry and physics, and everybody wants to come to the University of California.

Now I have presented, I believe, the major points I had in mind, looking at this through the eyes of a dean who is ultimately responsible for the administration, so far as the university is concerned. It has great merit. Something that has not been mentioned today, but which is deserving of consideration by our administrative officers, and that is the need of prevention of a vacuum of young men qualified to continue the work of the Manhattan Project. I suspect, as an outsider, that you may be faced with a real problem there, and one which may be, with a little prejudice, presented to universities as a patriotic duty. That may be a shot in the locker, Dr. Bradbury. I'm trying not to see this thing entirely as an administrator.

I would like to ask one more question, which is the matter of library facilities. Dr. Bradbury mentioned a few moments ago that many would want to read. I should be inclined to say all should be expected to do a great deal of serious reading. May I ask about the library facilities?

Dr. Reines (Los Alamos): I spoke to the librarian because I recognized that this would be an important question, and the status of the library is this: the University of California had loaned many books to the library to be used during the war and, at the same time, many books were purchased for the use of the library. Now that the war is over, many have been recalled but they are, at present, being replaced, and there is a buying spree on with respect to necessary books which would astonish a librarian if he weren't at Los Alamos. There is a very serious program now of building up the library so that it will be adequate for our research here, as well as for any students that come. At the moment many of the shelves are empty because the books and journals are at the binders, but within two months we expect we will have an adequate library.

Dr. Bradbury: The library has been, and will be, maintained at a level which is comparable, technically, with the rest of the laboratory. It had to be set up in the beginning as such, as was early recognized. It is purely technical; that is, we have nothing besides chemistry, mathematics and physics



books, with a few closely related sciences, some medicine, and things of this sort, primarily relating to these fields. This is a highly technical library.

In connection with the matter of either periodic consultant visits between actual members of your staff, you pointed out, Dr. Stewart, that it is questionable whether a man would want to spend his time entirely with a student. This I quite agree with; however, I think a man of such caliber to whom you would wish to give a task of this sort, would be a man whom we would like to have as consultant to us. He would come here as part of the laboratory -- a consultant to other members of the laboratory staff on other problems.

Dr. Stewart (U. of Cal.): Which in turn would make it more profitable for the individual professor, in view of the fact he would come here as consultant.

Dr. Bradbury: Quite so, the man would be appointed to do a consultant job, not to do a specific job, but as consultant to the project. He may do, and will do, many other things. The question of expenses can be handled on a consultant basis -- this is a payment of travel, plus so much per day.

Dr. Stewart (U. of Cal.): I would like to add one thing, -- I know that several other gentlemen here have the same point of view. We have taken official action at the university with respect to the consideration of requests from Los Alamos as well as from Naval Ordnance. This is a definite policy, for it is the thing that has been in effect and will continue in effect. We feel that in such an arrangement as you propose we must avoid a bracket group -- that each student must be considered individually by us, as well as by you. That is, we would not be willing to say that any student recommended by our department, and accepted by the project, would automatically, upon a fulfillment of requirements, be accorded a special dispensation. Not in the least. We would have to consider every case separately and as an individual case. However, I suspect that does not present a problem because we would be dealing with a restricted number of students, say, a top of twenty-five. Obviously, there would be probably not more than two students at any one time from any single university. I think such a diversity of sources would be an advantage to the Manhattan District.

Dr. Bradbury: Of course, the particular facilities of the University of California, along these lines, means that you will have facilities on your campus, and facilities equally extensive to our own in many fields. I see

no reason why your men should come here when the job can be done there. But there may occur occasions where we have facilities which would not be duplicated in the Radiation Laboratory of the University of California and for which there exists a desired use.

In this particular case, the more contact which the university can have with this project, in the direction and understanding and full acceptance of the work that is done, the more easily will it get around such difficulties. As a result, we feel very strongly that the more of that sort of contact we establish, the better for our project program. To some extent it may also be advantageous for the universities to be equally aware of what is going on in a laboratory of this sort.

Br. Buchta (Minnesota): I speak, not as a dean, but as one of the members of the council working with deans in the graduate school. Many questions have been answered, but I would like to point out, from our point of view, that we feel there are many difficulties. However, these are difficulties which might be called red tape. The fundamental approach should be the pursuit of ways of advancing science and training students. Having that as our goal, many difficulties will be ironed out. We do have regulations concerning candidates -- many would be met at once if a large amount of work were declassified. This would indicate we had gone a long way, to say the least.

I have a number of questions, one of which is this: have you found a possibility whereby a man may be here less than a year?

Dr. Bradbury: We have given thought to that particular problem. I think there is a possibility along those lines, though I should be inclined to believe the initial time would be not less than six months. I have the feeling it will take more than a month for the man, when he first comes here, to learn his way around, and in addition I would like to handle this problem in as nominal a way as possible. Normal employment policies are such that we would not like to employ a man for less than six months. There would be exceptions, and individual cases will have to be handled on an individual basis. If we had to bring him here, send him back, etc., it would be difficult to explain to the general accounting office if he stayed less than six months; therefore we set up this period of time as expectation of employment. It might be feasible to arrange a six months' employment period with possibly subsequent and shorter periods. We would do it on leave of absence basis.

Dr. Buchta (Minnesota): I presume it will be a shorter period for staff members.

Have you any idea what proportion work done by students would be declassified?

Dr. Bradbury: There will be a tendency to find problems which can be declassified. It simplifies the problem in many ways, and I expect that fifty to seventy-five percent of the work will be declassified. This is not necessarily so, but I would gather, from the tenor of this meeting, that there should be a definite effort made to find declassifiable problems. We are interested in the progress of science, and this means getting as much material declassified as possible, and we expect there will be a large amount of work declassifiable. However, we hope to find many people who are willing to undergo temporary difficulties of classified research in view of the physical interest which the problem on which they are working presents.

Dr. Glockler (U. of Iowa): I have been thinking about the possibility of picking these graduate students, and it occurs to me there are two ways -- to let him take his course work, then his languages, qualifying examinations, and then research work. There are also quite a number a graduate students interested in chemistry who don't follow the plan. They will start out with research, languages, follow with course work, and then the thesis. In that case, of course, it is quite evident we could not enter any arrangement with you. We leave more or less up to the student which arrangement he wishes to follow. Personally, I must say, I urge him to get through with the course hurdles, his languages, and other qualifying examinations.

When will you pick the research problem? Just when will I find that this man wants to work on a certain problem I hope could be worked on in cooperation with this laboratory? It isn't so simple to know how and at what stage to pick the man. Here is an example of our procedure at Iowa: I will describe research topics to the student. Some of them state right away they want to work in physical chemistry, and questions are discussed. They will then do nothing but readings. It is quite usual that the thesis is published with the major advice of the senior professor, and the thesis will usually be published under these two names. If you must have another advisor here, it will be three names on the paper. That is a question that occurs to me, Dr. Bradbury, and I would like to have your thoughts on these matters.

Another question: the student here might work on several machines. We have hardly enough time to get the students to work on their theses, and if you in addition send them all over the place I don't believe they'd ever get to their theses.

Here at Iowa the student must take his final examination on the campus

and it sometimes even happens that students leave for a job and have to come back to Iowa and take their final examination before receiving their degrees. In case of a doctor's degree, anything short of sickness or death cannot keep them from taking the test.

Dr. Bradbury: I quite agree, and we have discussed the problem here. There are two ways of proceeding. One is getting a large part of this course work done and then concentrating on the thesis work. In research this has advantages and disadvantages. We would have to deal largely in this way because, as you pointed out, jumping back and forth is not satisfactory. We would hope by choosing men with some graduate training that a man would not find himself without a moderate amount of formal instruction. We would not let him write his thesis without the necessary prior academic formalities of the classroom. I think we could probably work this out with your departmental staff.

Dr. Glockler (U. of Iowa): Do you have any problems as far as publication is concerned?

Dr. Bradbury: We have taken the definite point of view on several theses done here that the man publish his own paper; however, I think this should be arranged by the man and his guiding professor, and whatever policies which were adopted in that case would depend on relative guidance of your staff. We do feel that the man should have the majority of credit for his job.

As far as the use of different machines is concerned, this again would be a problem in which it would be arranged so that the university would be satisfied. Generally speaking, the man's activities would confine him to one special problem, or particular equipment.

The problem of final examination, I am sure, can be worked out, and from our point of view, leaves of absence, periodic or at the end, or whatever was required, could be worked out.

Dr. Kirkpatrick (Stanford): From what has been said, it would indicate this plan, as proposed, is already going on to some extent -- is that true?

Dr. Bradbury: We have had quite a few; I can't give you the exact number at present, perhaps five or ten theses which have already been presented and accepted at some universities. I have appointed a committee; this committee reports to me and I report what the committee concludes. In every case I have tried to include members on the staff of the particular university if possible.

Dr. Kirkpatrick (Stanford): The details of the plan, as you presented them, have been lenient, and from the experience to date it has been found they have worked?

Dr. Bradbury: We find there is considerable difference in philosophy between different universities, as might be expected, but in general, we believe these things can be worked out.

Dr. Kirkpatrick (Stanford): The laboratory has been carrying on work in nuclear physics, etc. One might think that they ought to be interested in metallurgy, and perhaps in electronics. Do you anticipate any other branches of engineering?

Dr. Bradbury: Yes, to some extent I do, although it is not felt to be feasible to go into details here because most of our electrical engineering problems and chemical engineering problems do not lend themselves very well to theses. However, there are special cases, and we would be very glad to discuss them. In particular, we have problems along electronic lines which may be of the stature that could be developed by one man in a reasonable length of time.

There are also some other problems of great interest such as those concerned with equations of state, hydrodynamics, shock waves. These are not problems that would ordinarily occur to the average institution. We experience difficulty in getting these problems out to the light of day, and to the student, frequently because of classification. But problems of that nature, as indicated this morning, are problems in which we have a great interest and which would set up a very good thesis.

Dr. Gustavson (U. of Nebraska): Would the field also go into biological work, or is it restricted mostly to physical sciences?

Dr. Bradbury: We are undertaking, with the active cooperation of Washington University, a very extensive program in bio-physical research, associated with particular problems which the material of this project brings to us. Actually, Washington University is taking the responsibility of carrying out that work and Professor Hughes might want to comment more on this arrangement.

Dr. Hughes (Washington University): So far as the medical work and associated biological research conversations have been conducted by representatives of Los Alamos and Washington University -- plans whereby the

university will take the responsibility for supplying men of the right caliber, subject to acceptance by Los Alamos, the advantage seems to be mutual. As far as I know, the actual preliminaries seem to be satisfactory to both sides.

Dr. Jacobs (U. of Iowa): Does that mean that any medical work, biochemical and bio-physical work will be conducted by the University of Washington?

Dr. Bradbury: Yes, in a general way, although the responsibility of the project will, of course, remain.

Dr. Worcester (U. of Colorado): Concerning theoretical physics, it has been mentioned that a year's time might be required for a PhD thesis and part of that time to learn the laboratory procedure, etc. Could that be done, perhaps, largely at our own university, perhaps with consultant work here, making use of experimental data? Would that be available in case of theoretical problems?

Dr. Bradbury: When we spoke of a year, we were thinking of experimental problems. I think this could be worked out, depending upon the nature of the problem and extent to which the problem could be set up, but this involves considerably more discretion. An outline would probably have to be set up and I'm afraid frequent visits would be required of the man.

Dr. Worcester (U. of Colorado): I have a man working on a theoretical problem that might involve use of machines, that's why I ask.

Dr. Bradbury: That could be worked out.

Dr. Gustavson: (U. of Nebraska): I think we institutions of higher learning have a tremendous responsibility to keep America strong in the fields we have been discussing today, and we have a marvelous opportunity in this. The project has taught a great lesson of cooperation, and institutions through the country are recognizing it. In connection with the Argonne Laboratory, there is a very definite plan of cooperation in research, in connection with university facilities. There is a very definite program being considered of accepting work carried on at other universities which, it seems to me, is a very fine thing, and would indicate American growing up, academically. We do have some precedent for that sort of thing where, e.g., Woods Hole work has been carried out in a fashion -- outside of the fact that no problem of security is involved in that research. I was very glad to get the report on biological research and I have a few questions I would

like to ask. Undoubtedly, as men come to work at Los Alamos they will be covered by insurance, I presume, against accidents and health hazards. What is the legal responsibility of Los Alamos to the university relative to injuries on the project?

Question: In connection with classified research, or partially classified research, how are we going to avoid problems of duplication if there is established in the northeast a regional laboratory, one at Argonne, one here at Los Alamos, and in California? Wouldn't it be wise to have some sort of a clearing house on problems to assure us secrecy is not leading us into duplication?

Question: With respect to the size of the stipend -- seems the logical thing would be to have a salary range of \$2400 to perhaps \$3500. In that case, what about the living costs at Los Alamos?

Question: Couldn't we meet some of the problems of interchange between universities? After all, we are getting a tremendous gift from Los Alamos in having the opportunity to use the facilities of this laboratory.

Dr. Bradbury: An employee of this project may be covered by several types of insurance. Workmen's Compensation under the laws of the State of New Mexico is applicable. Conventional group accident and health insurance is available to the employee at his own expense on very reasonable terms. In addition there exists a fund which may be available as compensation in the event of accidents arising out of some of the special hazards of the project. I do not believe that a University would have any liability, but I would have to have legal advice on that point.

The problem of classified science is not a new one. Since the close of the war I think the situation in the Northeast, Argonne, and Clinton has been quite similar to that here. We in the Manhattan District have instituted a system of information interchange which at present consists in periodically listing document titles pertaining to all fields of research in chemistry and physics, except those fields which actually pertain to the construction of the weapon. In the latter case, no one is particularly interested, except ourselves. These title lists are available within the confines of the Manhattan District. The problem of the dissemination of information is handled partly by that method and partly by recently instituted periodic research meetings. The Manhattan District laboratory is set up so we can know what is going on within the District even though it can't all be published now. I think that we can say that the necessity for access to the work that is being done in other parts of the Manhattan District has been recognized and has resulted in such a mechanism for the internal publication of documents.

Living costs are extremely modest. The housing basis we use is that set up for government housing by the FHA or Civil Service. Apartments will run from \$33 to \$67 a month. Dormitory rooms will run from \$15 a month up. At the present time, we have a commissary at which all employees are entitled to purchase supplies. One can get meat, butter, etc., and I think living costs, in general, are less. There will certainly be no objection to universities bearing part of costs of travel if it turns out that students will have to make more trips than one. We would have to govern our interpretation of whether we could allow consultation travel expense. If you are going back to consult with a man who is working on a problem, we would be able to support from this end; if taking an examination, this could not be done.

Dr. Nielsen (University of Oklahoma): I would like to make a couple of remarks from a point of view different from that of Dean Stewart. I'm not a dean, although I happen to be on a committee such as mentioned by Dr. Buchta. I'm from the University of Oklahoma where, up until now no work has been done in nuclear physics. We're going to have two faculty members who have done work in nuclear physics trained at the University of California, and I think I'm right when I say that we, at the University of Oklahoma, which is a rather young university, look upon this possibility of cooperation as an opportunity. We hope that through this cooperation it will be possible for young men from Oklahoma to get a better chance in this field than we can give them. We also hope that this project will help us to develop nuclear physics and chemistry faster than we could do without this cooperation.

Dean Stewart emphasized the point of differentiation between degrees done under faculty supervision from honorary degrees. Frankly, I think that these fears are more or less imaginary. I think the only thing we need to consider is whether or not the job that the student has done, the course work, and research is worthy of a doctor's degree; whether it is done under supervision here or in our own university. We have, as all universities have, a large amount of red tape, more than I think we ought to have, or need to have. But most faculties are perfectly ready, whenever the occasion arises, to cut through the red tape. I don't think these formal difficulties will be serious. I think the realities will guide us rather than the formalities.

I'd like to point out what seems to me to be the greatest difficulty in such a program. This question was touched upon by Professor Glockler. This scheme of the student's first doing all course work and general examination, and then spending a year on research here, is somewhat difficult. It is customary, as you know, for the student to do research and the course



work more or less at the same time, and work for these two years on research, and if he holds an appointment as graduate assistant, sometimes work three years. I'm wondering if it would be possible to make some such arrangement as this? If a university has a student who is capable, and has an interest in the type of work being done here, to approach this laboratory and go through some of the first procedures of clearance and plan the work several months or a year before the student actually comes here. In that way it would be possible for the student to plan his work in such a way that he will be better prepared for his work here and the concentration of research here in one year would not be quite as difficult under other circumstances.

Dr. Stewart (U. of Cal.): Maybe I didn't express myself clearly about this matter of degrees, earned and unearned, correspondence and honorary, and regularly earned degrees. I think I am speaking for most of the graduate deans in the country. We have discussed comparable things at the Association of American Universities at dean's meetings. I agree there is a lot of red tape and I assure you I believe in cutting it, but there are some problems that do count up. The point I had in mind is this: a matter of precedence: the larger the university the more you have to guard against establishing undesirable precedence. If we set up a cooperative project, such as that under discussion, we must recognize the probability that there will be comparable suggestions presented to our various universities. So far as this matter of doing work, good work that is deserving of a degree, is concerned, there is no argument against it and yet, considered above, it is full of danger. I don't want to guess the number of requests I get from students who have been at the University of California doing some graduate work, possibly a good many years ago, and since that time have been working for an oil company, or some other organization, where there has been enough to do in research. These people write in regularly asking to submit that work as partial fulfillment, the remaining fulfillment, for the degree. We consistently and regularly refuse such a man. A man cannot go more than four or five years, after taking qualifying examinations, and continue towards his degree. In nine out of ten cases he has forgotten a number of things he should know. I probably did not make my point clear. I think it is a real issue, administratively, and in drawing up any plans here I think it is absolutely necessary to take into consideration this danger and protect ourselves against it. There is a distinct difference between an honorary degree and an earned degree, and certainly your universities are going to insist upon keeping these distinctions. I know the University of California is.

Dr. Bradbury: The remarks of Dean Stewart are pertinent. We, of course, are interested in maintaining the standards of the PhD degree. We

also feel that the university must maintain the academic control of the student; that, I think, is the point you made. We have been very careful to insist that this is a relation between the university and student that is satisfactory to each. Locally, I think both your point of view and that of Dr. Nielsen are completely reconcilable. Universities may differ in the extent in which they may have a hand in the direction of the student. This may depend on the staff, but I think there is no argument that the university must be satisfied that it is their student doing the work. This is what we insist upon. If this cannot be done, we have no interest in it.

With regard to the second question, and that is the procedure whereby the student may consider a problem in advance: to tie down a specific problem six months in advance would be ill-advised. The man could work in a general field in preparation for his research, but to settle on a given problem would mean to tie it up for six months and so delay its solution and run the risk that it will be done elsewhere by someone else. In addition, if it's a good problem it's hot, and we would like to see it done with dispatch.

Dr. Weniger (Oregon State): I am an administrator of graduate work and would like to suggest that when the graduate writes in to present a thesis from an oil company, etc., that it be considered as work toward an engineering degree. We just made an engineering degree and got rid of all the people very nicely. Now, of the things that have been mentioned here, and the various rules, I haven't noticed any that couldn't be satisfied. If there is no objection, we could have an arrangement with the student to come back to the original campus for one year, or the necessary time after he completes work here at Los Alamos.

Dr. Bradbury: We would have no concern as to when or where he satisfied his academic requirements. It may even be possible for the actual writing of theses to be done away from Los Alamos. It may be necessary to make return trips here periodically; that, again, could be handled in one way or another. The man himself would probably have to handle it.

Question: Is it necessary that the appointment go up to the end of a certain fiscal year?

Dr. Bradbury: No, we have no tie-in with the fiscal year.

Dr. Van Atta (U. of Southern Cal.): This brings out the question of the permanency of the proposition.

Dr. Bradbury: We felt we would not begin to see any results before

the beginning of the academic year in the fall. The project is permanent, at least until June 1947. Funds already exist, so I see the proposition at least as far as that. This will mean, I think, that since students will show up at the universities first, we will see students coming here in October, November or December; otherwise there is no particular time.

Question: Will you be able to make any estimate of this: suppose a student suddenly decides he would like to do that at a particular time. What would be the time in which he could be cleared before he would start here?

Dr. Bradbury: Security clearance with the governmental agencies takes four to six weeks; sometimes it is shorter, and sometimes longer, -- it depends entirely on the individual, where he has lived, etc. I would say something like four weeks would elapse from our acceptance and the beginning of the investigation before he would go on the payroll.

Question: Would a man advising students have a choice in problems? Would he be able to choose from a list?

Dr. Bradbury: We would feel it our responsibility to suggest problems which had occurred to us as jobs falling very closely in connection with our work. We would, of course, first discuss with the student the merits of doing this job as opposed to some other job.

Dr. Jacobs (U. of Iowa): I'm particularly interested in this question of classified information. I don't know what the general opinion here is but quite a few of us feel that now that the war is over we would be very reluctant to engage in work that must be classified. I think we would have a great deal of difficulty if a thesis could not be written and then submitted to the university.

Dr. Bradbury: I know you represent a general feeling on this matter. I can only say this is a circumstance which is completely out of control of the Manhattan District. Permission to declassify material has to be obtained from the President. We feel that these things are the general background of physics and chemistry and should be public knowledge, but the actual plain fact is that there is no governmental authority to do this.

Dr. Jacobs (U. of Iowa): If general opinion feels that this is desirable, there might be pressure placed on governmental authorities. What is the area in which the work could be unclassified?

Dr. Bradbury: The character of the legislation which is now pending

before the House implies there will be a greater release of this information than has heretofore occurred. There is declassification of a great deal of basic work, and I am inclined to think that the whole feeling of the scientists in this country is along the same line. There is a real possibility that by the time the whole program is in effect this will be a solved problem; therefore by considering only declassifiable material as of July, 1946, we may fail to consider many problems which will be declassified later.

Dr. Gustavson (U. of Nebraska): I think that the history of the feeling of the group in Chicago will be of interest here. After the cessation of hostilities they were not willing to engage in any work of a classified nature. Yet this has changed, and the feeling of the Chicago group is now much the same as you have expressed. They feel that this is a transition, and that a certain amount of playing along with this has to be engaged in. You also have to remember that, to start out with, although the subject seems to be clearly of a declassified nature it may develop into something which is highly classified. Another question -- can this laboratory be interested in offering training apprenticeship in certain areas, e.g., suppose someone wants to learn the techniques of making measurements on carbon, is there any plan on which he might come here and learn the techniques, and go back to his own laboratory?

Dr. Bradbury: There is no plan of that nature. There will be no objection in principle to that arrangement, but he would have to accept the fact that we would expect in advance a certain duration of employment -- six months to one year so that our normal personnel policies would apply. We have not gone into that particular phase of things. If we did, he would be on the regular employee basis. Here is a man who wants to come to us -- we find he can do a certain job; we would expect, before we put him on the payroll, that he would stay a certain length of time.

Dr. Jette (Los Alamos): I would like to make a remark on the classified subject matter. Our main objective here is to protect the student against having the direction of a thesis change from something that was apparently unclassified to one that might be classified. We would not like to see a student start in on a job in good faith and have it turn out at the end of his job that he can't get it published. We believe if anyone takes a beating on this it is the university which should, by making arrangements to accept classified material and thesis before it. I am going to suggest one way of satisfying the library requirements, whereby a certain number of copies of theses must be deposited in the university library. Namely, you have a file, a locked file in the university, the combination of which is known only to the local army security officers.

Dr. Jacobs (U. of Iowa): I am not sure that I approve of the spirit behind this. The rule should not be broken -- the act of placing a thesis in the library to see that some of this information that has been accumulated is available to the rest of the world is in the true spirit of a free science. If it is a patriotic duty to work on secret gadgets in time of peace, it seems to me fundamental that the progress of science and secrecy aren't compatible.

I believe that in peace time most universities will not be able to say that they will be able to give blanket agreement accepting the work regardless of whether it turns out to be classified or not. It seems your responsibility should be that when a man starts on a document in good faith, someone at Los Alamos should see that it is not classified.

Dr. Bradbury: If we knew the answers in advance we could do this. You will not find something classified occurring in most of the problems. If it does occur, I am sure that the student who has done it would be delighted to have accomplished this particular work.

Dr. Smythe (C. I. T.): Are you going to classify things that were not classified before the war? A good many things would be discovered here. Even in the field of research of nuclear physics you may easily discover things that should be classified.

Dr. Bradbury: That is true. These are problems which exist and which are being worked on. These are the difficulties characteristic of security in peace time. These things occur now, but I think next year will see a great many difficulties solved.

Question: Don't you think it is likely that the university which hadn't considered this point could find a way out when the time arrived?

Dr. Bradbury: I am sure we could.

Dr. Stewart (U. of Cal.): I think we are making a more serious problem than actually exists. Someone stated that it would be the duty of the laboratory and university not to penalize the student, and I believe that if a university is willing to cooperate and recognize as, I think, each university must recognize, that each case be an individual case, that it would be a very simple matter. I can see no objection why you would not easily agree in advance that it might be classified work and make arrangements in advance. If we do that, we are not going to penalize students.

In respect to the library -- there is a responsibility in the matter of filing doctors' theses, something that is sometimes rather difficult, and with

considerable frequency people write into the library to borrow a thesis. Students can't be reached and we feel we cannot release that thesis because it is always dangerous that it will be published as original work, without giving credit to the student. The idea of locking it up isn't such a bad idea.

Dr. Worcester (U. of Colorado): It does seem to me we are making a mountain of a molehill as far as classified and unclassified thesis material is concerned. If we are willing to go into this project at all we are going into it with our eyes open. You said you might take from 15 to 25 graduate students a year. There are fifteen universities represented here now. This would make an average of one student in difficulties with respect to publication from each university -- one in four or five years. Perhaps an institution might be confronted with suppressing the publication of a thesis. I don't think it serious. If we believe in taking advantage of the opportunities we have, we would believe it worthwhile not to publish a thesis every four or five years.

I wanted to ask a question. I feel that many university administrators are not going to encourage leaves of absence for members of its staff. We have all been through a long period of war -- many have been teaching long hours, and we need to get away. It seems to me rather than carrying the idea to this meeting that leave of absence will be hard to get that we believe that they should be easy to get. We ought to do everything to encourage it. It may be, however, that a year's leave of absence is impossible. What about three to six months for the members of the faculty? Couldn't they do something worthwhile in this length of time?

Dr. Bradbury: We have discussed this problem and have agreed that this is possible. Three months represent a lower limit, but it would be worthwhile for a man to come for that length of time. Three months is a short time to get results unless the man is interested in a going concern, a problem in process; but between three to six months is a feasible arrangement and a man might make a definite contribution in that time.

Question: What about the possibility of exchange? Do you feel that you have men here at the laboratory that would be interested in going to a university for a year in exchange, or would it be a one-sided exchange?

Dr. Bradbury: This would be a proposition that would interest some of our people. I mentioned that the background of the project is highly academic -- many people have been missing academic association. To be able to return to the classroom means a great deal to people, and while I can't say for certain, I have the feeling that this would be an attractive opportunity

for some of our people. That is why we mentioned courses. People like to instruct, if there isn't too much of it.

Question: It seems to me that is a very important matter. It is extremely difficult to get competent teachers, and if we are going to be able to send men down here to the laboratory, we must get replacements; otherwise it isn't going to work out.

Dr. Bradbury: I can certainly concur that leaves of absence are hard to get. I would like to say that I feel this problem of exchange is one we would be interested in working on. I think it is an established fact that the best research seems to be done in academic institutions in an academic atmosphere. A project of this sort should endeavor to obtain academic associations.

Question: We don't know about the effects on the bodies of individuals. This matter occurred to me when Dr. Gustavson asked about the insurance. What about long-range effect of radiation on humans?

Dr. Bradbury: This is the reason why this particular fund which I mentioned previously was set up -- to take care of things we don't understand. All our knowledge is based on present experiments on animals. This is a new field and we are prepared to take care of people over a long period of time; that is why I mentioned that we plan to study the bio-physical aspect of radiation.

Dr. Smythe (C. I. T.): Special requirements in different departments at Cal Tech are entirely different, so anything I have to say has nothing to do with chemistry. I have listened to various discussions and I think there are several ways Cal Tech could use this laboratory. We have, I think, fifteen or twenty-two starting their PhD's in nuclear physics, and such students, I think, are certain to turn up problems -- some theoretical and some experimental -- which, in the course of development reach the limit of our facilities. When that happens, it seems to me the logical thing to do, rather than to drop a problem at this point, would be to see if we could make arrangements with you for these students to come here. Most of them will have done a considerable amount of graduate work. I am quite sure the cosmic ray group will be turning up problems which will definitely indicate they must go somewhere where they have the equipment. Arrangements would be desirable for such men. One thing it was suggested I ask about in particular was the possibility of post-doctoral work. We have lots of men who work in the field, have theoretical background, and some experimental, but really have only a limited knowledge of nuclear physics. Is it possible for

men -- competent experimental men -- who have a pretty good knowledge of the field to obtain a post-doctoral fellowship at Los Alamos? Could these men come and work two years, or permanently? They would want to get experience with the facilities here for research in nuclear physics.

I think that, unless we can get around the red tape, there is not a very good chance that our men will work on problems originating here for PhD theses. We are under pressure to accept, as thesis work, done by former students, some who have quit for one reason or another, but who have subsequently done work outside that is perfectly suitable for a PhD. If we ever started accepting such work for PhD theses we would be running ourselves in for something. No one can certify, for example, that the work was done by that man alone. Furthermore, he may have been working in some narrow field and forgotten all the training he has had. When you give a man a PhD he is supposed to be qualified to do anything that a physicist (or chemist) is supposed to do, and he may want that degree to get a job. The problems will have to originate at Cal Tech.

About the security question. We already have locked up tight a number of theses, and it is not very satisfactory, but in every case we had a promise that the material would be released. We had certificates from members of faculty cleared on that particular topic that a thesis was of suitable quality, and the graduate school was willing to accept on their recommendation.

Now, in connection with the Navy. We have been working on some subjects ourselves, and we have come up to the authorities with work about which we didn't know the security status. We were informed that it was highly classified. The fact that we had communicated with them on this subject in their opinion seems to make us responsible for maintenance of security on that topic. I wonder if that is likely to happen here.

Dr. Bradbury: I think I can answer the particular question regarding the authority of this project to classify experimental work done outside and not under contract with us. We would not have any authority to classify such work.

Dr. Smythe (C. I. T.): If we have communicated with you and signed a statement that we have discussed the subject with you, we are not put on the spot, then?

Dr. Bradbury: These are very delicate questions. There has been a considerable amount of voluntary classification. If the research is carried



out, then as far as I know there is no applicable law other than the Espionage Act. However, research making use of government funds falls under the classification policy. All we can tell you is, if that work were being done here we would have to classify it. If it were continued here and worked on, it would be classified. The patent feature is also related to this question of research done using government funds. The patent obtained on work done with government funds would belong to the government. There are questions as to the original patent belonging to the university and the improvements belonging to the government which will take years to straighten out.

Question: What about foreign students? Can they be cleared?

Dr. Bradbury: It is desirable that our employees be American citizens by birth or naturalization.

About the question of employing men for post-doctoral work; as far as we are concerned they would be regular employees. They would be employed in accordance with our accepted personnel policies and, of course, be paid more than a man with less experience. I think it would be possible to make very adequate salary arrangements.

Dr. Froman (Los Alamos): It should be noted that if a graduate student came to this group and invented a gadget, it belongs to the United States.

Dr. Bradbury: Since a person is employed by government, any patent he has belongs to the government.

Dr. Van Atta (U. of Southern Cal.): Regarding arrangements between the university and the Los Alamos Laboratory: it occurs to me that for an arrangement to work out satisfactorily it should be of permanent standing. A record should be kept of the participation in the work by members of the university staff, through consultant capacity, for members of the university staff. It seems to me that for the work to progress satisfactorily, it would be desirable for that contract to be made for a definite period and continue so that the consultant would have a very good prospective for carrying on the work done here; so he could direct students into some definite channels. Then I believe an arrangement would be satisfactory.

Generally a student gets into his research job by degrees. If an arrangement were worked out by which students could come here for a period of three months, they might assume the status of helper in laboratory work. They would learn a great deal which would mean a great deal in their future studies. There is one disadvantage. The interval spent on that basis would

be short -- three months -- equivalent to a summer vacation. However, I would believe such an experience would be extremely valuable. Even from the point of view of contributions to the laboratory, for he would eventually come on a thesis job and be more effective when he does.

Dr. Bradbury: It would not be possible for the project to pay transportation, as I have indicated. That prerogative is only available for a reasonably long-term employment. However, if a man wanted to get himself here it might be possible to allow this. It might be necessary to stagger such requests, but I quite agree that such primary training would be desirable and would help the man.

Question: Some of the men who come here have children of school age. Is there a school?

Dr. Bradbury: Yes, also adequate hospital facilities.

Dr. Smythe (C. I. T.): About the post-doctoral arrangement? I think these men would not wish to be quite regularly employed, they would not wish to be primarily permanent regular staff members, although it is quite possible they might consider this. They wish to become familiar with the different techniques in nuclear physics. They would not be requesting a very high salary -- they would merely want to break even.

Question: How do you intend to proceed from this point to implement the plan of university cooperation we have been discussing today?

Dr. Bradbury: I think we have underscored the fact that there would have to be almost individual arrangements with each institution. We are now ready, or will be next September, and thereafter, to undertake the sort of program we have indicated here, to receive students subject to our approval, with whatever degree of consultation or supervision the university in question finds it desirable to suggest and which is acceptable to us. I do not believe that, with the problems of different universities, it is possible to write down a set of rules. We can probably find our way to cooperate on all problems. What I think we can do, and should do at this time, is to prepare, at the Project's expense, an abstract of this meeting. We will arrange to send you several copies so you can distribute them where you think best.

I think it would be appropriate for you to write me a letter stating the situation as it appears to others at your institution. In that letter they may wish to ask questions which apply to your university.

**APPENDIX NUMBER 6**

**NUCLEAR PHYSICS CONFERENCE PROGRAM**

**This conference was held at Los Alamos in August 1946. (See par.1. 23.)**

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# NUCLEAR PHYSICS CONFERENCE PROGRAM

19-24 August 1946

Los Alamos, New Mexico

## Monday Morning -- Chairman, J. M. B. Kellogg

Opening Address

Accelerating Equipment at Los Alamos

Chain Reactors at Los Alamos

N. E. Bradbury

John Manley

Philip Morrison

## Monday Afternoon -- Chairman, R. F. Taschek

High Temperature Pile

Reactor at Oak Ridge

Particle Detection

Oliver Simpson

Harry Soodak

Hana Staub

## Tuesday Morning -- Chairman, Egon Bretscher

High Energy Accelerators

Linear Accelerator

Synchro Cyclotron

Synchrotron

Robert Serber

Luis Alvarez

Robert Thornton

Edwin McMillan

## Tuesday Afternoon -- Chairman, R. R. Wilson

Fission Process

Some Heavy Isotopes

Fission Process, Chain Lengths

Energy Spectrum of Spontaneous

Fission Fragments

Eniacalculations on Liquid Drop

David Inglis

Glen Seaborg

Katherine Way

Emilio Segre

Nicholas Metropolis

## Wednesday Morning -- Chairman, R. P. Feynmann

Light Particle Scattering

Resonance in Particle Reactions

(Possible Short Subjects)

Resonances in Disintegration of

Fluorine by Protons

n-d Scattering

Julian Schwinger

E. P. Wigner

T. W. Bonner

C. L. Critchfield

Wednesday Afternoon

NO MEETING

Thursday Morning -- Chairman, L. D. P. King

Neutrons as Waves

Scattering by Micro Crystals

Enrico Fermi

R. G. Sachs

Thursday Afternoon -- Chairman, Rolf Landshoff

Fast Neutron Processes

(Possible Short Subjects)

Potential Well Calculation

Scattering of Fast Neutrons

Victor Weisskopf

Frederick Reines

D. L. Hughes

Friday Morning -- Chairman, Edward Teller

Nuclear Induction

Quadrupole Moments

Very Short-lived Isomer

Felix Bloch

I. I. Rabi

S. De Benedetti

## APPENDIX NUMBER 7

### DESCRIPTION OF TECHNICAL SERIES

Title and brief description of each volume being written for the Los Alamos Technical Series. (See par. 9.7.)

Editor's Note, 1961. This series has not been made available for outside distribution except for Vol. I, published by McGraw-Hill Book Company, Inc., in the National Nuclear Energy Series; Vol. IV, published by the Government Printing Office; and Vol. VII, a portion of which was issued as LA-2000 (Unclassified), available from the Office of Technical Services, Department of Commerce.





## CONTENTS OF THE LOS ALAMOS TECHNICAL SERIES

Volume No.	Title and Description	Editor
0	<p>"Relation Between the Various Activities of the Laboratory"</p> <p>(A general survey of the work of the Los Alamos Laboratory during the war years, with particular emphasis upon the problems of the critical mass and of the efficiency. In addition to a discussion of the gun and implosion type bombs, the volume contains a section dealing with other methods of attaining the explosive release of nuclear energy.)</p>	S. K. Allison
I	<p>"Experimental Techniques"</p> <p>(A description of the experimental physics equipment used by the Los Alamos Laboratory. The volume has three parts: the first dealing with electronics; the second with ionization chambers and counters; and the third with miscellaneous techniques used in obtaining physical measurements.)</p>	Darol K. Froman
II	<p>"Numerical Methods"</p> <p>(A survey of the methods used in performing numerical calculations of various types of equations by hand computation and with the use of International Business Machines.)</p>	Eldred C. Nelson
III	<p>"Nuclear Physics"</p> <p>(A comprehensive report of nuclear physics measurements made by the Los Alamos</p>	R. R. Wilson

Volume No.	Title and Description	Editor
	Laboratory, together with theoretical evaluations of results and a detailed discussion of the fission process.)	
IV	"Neutron Diffusion Theory" (The theory of diffusion with and without a change in velocity, including a discussion of statistical fluctuations.)	George Placzek
V	"Critical Assemblies" (A report of critical mass experiments made at Los Alamos with uranium-238 and plutonium assemblies for various tampers. A theoretical discussion is included.)	O. R. Frisch
VI	"Efficiency" (A theoretical method for calculating the energy release of a nuclear explosion.)	V. F. Weisskopf
VII	"Blast Wave" (A study of blast wave phenomenon, both from a theoretical and an experimental point of view. Particular emphasis is placed upon the behavior of the blast wave in large explosions, and an effort has been made to interpret blast data from studies made at Trinity, Hiroshima and Nagasaki.)	Hans A. Bethe
VIII	"Chemistry of Uranium and Plutonium" (A survey of the problems concerned with the chemical purification and recovery of uranium and plutonium, together with a discussion of the preparation of their various compounds and of the analytical methods used in their study.)	Joseph Kennedy
IX	Not assigned.	

Volume No.	Title and Description	Editor
X	"Metallurgy"  (A report on the metallurgy of uranium, plutonium and all other metals fabricated by the CMR Division.)	Cyril S. Smith
XI	"Explosives"  (A survey of the experimental work done by the Los Alamos Laboratory on the behavior of explosives and on the techniques of explosive casting.)	G. B. Kistiakowsky
XII	"Implosion"  (A report on the experimental implosion program from the early tests to the development of the Trinity bomb. The volume covers work done on polonium, radio-barium and radio-lanthanum.)	R. F. Bacher
XIII	"Theory of Implosion"  (A theoretical survey of the implosion process. The volume contains discussions of shock hydrodynamics, equations of state and various implosion designs.)	R. E. Peierls
XXI	"The Gun"  (A survey of the experimental gun program from the early tests to the development of the Hiroshima bomb. This volume includes design specifications and a discussion of the interior ballistics of the gun.)	F. Birch
XXII	"Fuzes"  (A study of work done by the Los Alamos Laboratory in designing detonating fuze assemblies for the implosion and gun type bombs.)	R. B. Brode

Volume No.	Title and Description	Editor
XXIII	"Engineering and Delivery" (The history of Project "A" together with a discussion of engineering problems encountered in the delivery program. Particular attention has been given to the mechanical design and assembly of the Model 1561 implosion bomb.)	N. F. Ramsey
XIV	"Trinity" (A complete report on the 100 ton TNT calibration and rehearsal shot and the July 16, 1945 atomic bomb test at the Alamogordo Air Base. The volume includes both experimental and theoretical discussions of the various phases of the test. A large appendix contains all pertinent Trinity memoranda and all LA and LAMS reports concerning the Trinity explosion.)	K. T. Bainbridge

APPENDIX NUMBER 8

COPY OF BRADBURY'S LETTER TO ATOMIC ENERGY COMMISSION

Outline of problems facing the Los Alamos Laboratory at the end of 1946 together with a brief history of the project from its inception.



November 14, 1946

Atomic Energy Commission  
Washington, D. C.

Gentlemen:

1. Of the many problems facing your Commission, that presented by the Los Alamos Laboratory may well not be the least. For this reason, the senior technical personnel of the laboratory have given much thought to its proper role in peacetime under the existing legislation. Although no single statement can completely reflect all the varied opinions of many individuals, there is, nevertheless, sufficient unanimity of thought to warrant its presentation to you in this manner.

2. The Los Alamos Laboratory was established under war conditions and with the greatest secrecy in 1943. The aim of the laboratory could be stated simply: to devise and produce an atomic bomb, and, if necessary, continue to produce more bombs. Since adequate knowledge of many basic nuclear constants was lacking, an elaborate laboratory for experimental physics was set up with all the relevant equipment for research of this character. To interpret these results, to design a weapon around them, and to predict its behavior, mathematicians and theorists of the highest caliber were active in a Theoretical Division. The chemistry, chemical engineering, and metallurgy of the active materials except in microscopic quantities being almost unknown, heavily staffed divisions were set up to contend with these new and complicated problems. When it became apparent that high explosives would play a prominent role in a heretofore unknown way in the assembly of active material into a super critical assembly, appropriate experts attacked the problems and established a research pilot plant for the study and production of high explosive charges of the necessary quality and character. Other divisions attacked the problem of the experimental study of the assembly techniques in order that the probability of success of the weapon might be high on its initial attempt. Finally, due to the urgency and secrecy of the whole problem, another large group of scientists and engineers formulated and solved the entire problem of ordnance engineering including the method of delivery of the weapon and its ballistic behavior. In many of these diverse responsibilities the laboratory drew upon other organizations and subcontractors and was responsible for the direction and coordination of their efforts.

3. The success of all these efforts is known to the world. With the close of the war, the original directive of the laboratory was completed and no new general directives carrying national approval or acceptance were to be found. The confusion of the nation and the world with respect to this new weapon was reflected in Los Alamos. The majority of the most senior technical personnel returned to their old or to new academic institutions; many of the younger personnel hastened to accept academic appointments, positions in industry, or returned to colleges and universities to complete work for academic degrees.

4. It soon became clear that atomic energy legislation would not immediately be forthcoming and that the Manhattan Engineer District would be directed to maintain essentially the status quo until such legislation was available. From a variety of personal motives, but all having in common the belief that to abandon work on atomic weapons and the fundamental processes involved therein was contrary to the best interests of the nation at this time, a considerable number of individuals elected to remain with the Los Alamos project until there was clarification of national policy in this field. During the course of the following year, other scientists, many of whom had not previously been connected with the Manhattan District, joined the Los Alamos Laboratory. Despite the departure of most of the nationally and internationally known scientists associated with the project during the war, many of the men who had worked with them remained and took over technical and administrative responsibilities. While not at its former extraordinary level, the technical status of the laboratory remained high.

5. The philosophy and directives of the laboratory during the last year have been developed partly internally and partly externally. The Manhattan District took a definite interest in the stockpiling of weapons of the type in existence at the close of the war. Towards the end of the period, an interest was also taken in establishing purely military units to take over the ordnance assembly, delivery, and logistic problems associated with the weapon. The participation of the laboratory in the Crossroads Operation was the result of a directive from the Joint Chiefs of Staff through the Manhattan Engineer District.

6. For itself, the laboratory proceeded upon a general philosophy that it would endeavor to set up and maintain a program which represented the best approach to its own conception of the nation's need for a laboratory concerned with atomic weapons, both present and future. Believing that the



present weapon was primarily the fruit of fundamental research extending over a period of years, it was considered that such research should play a definite role in the life of the laboratory. Such research has been conducted in all the technical fields which bore upon the development of the weapon. This includes not only nuclear physics and chemistry, but high explosives, equations of state, radiation, hydrodynamics, and phenomena of solids. Since the development of many portions of the weapons had proceeded on an almost entirely empirical basis, attempts were now to be made to increase the understanding of the processes involved.

7. Because of this interest in basic research and our conviction that such research alone can provide the foundation for a strong nation, we have undertaken two major developments, which, while they will bear upon fundamental weapon research, will contribute equally strongly to basic scientific advance and to the peaceful uses of atomic energy. These developments are: first, the construction of a large pressurized Van de Graaff accelerator to replace the one returned from this project to the University of Wisconsin, but capable of reaching voltages up to eight or ten million volts; and second, the construction of a nuclear reactor of approximately 10 KW output operating on fast neutrons and utilizing plutonium as active material. Design work has been completed and some procurement started upon the accelerator, and the reactor is expected to be in preliminary operation early in 1947.

8. Since the close of the war found the present type of weapon in a stage of engineering development such that the probability of successful firing and functioning was unknown, a program of establishing this reliability was set up. The weapon itself was aptly termed during its development a "gadget". Some effort was to be spent in improving the engineering of the whole model. The demands of the Crossroads Operation interfered seriously with these objectives which cannot yet be said to have been obtained.

9. ...

10. Again, at the close of the war, it was known that a possibility existed of employing elements of low atomic weight in a "Super" weapon which, if capable of development, would be thousands of times as effective as the present weapon. Since the program for such a weapon as then conceived would involve a laboratory fully as extensive as Los Alamos at the peak of its activity, and would require as well large developments in other portions of the Manhattan District, the interest of the laboratory was restricted to determining the feasibility of the weapon and to research and theoretical

calculations bearing towards this end. These investigations, in which we have had the advice and consultation of previous experts in this field, have led to no decrease in our expectations that such a weapon could be constructed were the necessary effort to be expended thereupon. Furthermore, there has appeared a somewhat different suggestion as the result of these considerations which indicates the definite possibility of a weapon many times superior to the present one but lying reasonably within the capabilities of the laboratory.

11. The explosives research has concentrated upon gaining a better understanding of the unusual techniques involved in the weapon. Conspicuous advances have been made in the development of certain types of materials which have an explosive-like behavior in lenses and have certain special advantages for the weapon, but which are by themselves largely inert.

12. The production aspect of active material chemistry and metallurgy has required extensive development as, at the close of the war, a new plant for the production of active material had not yet been put into actual operation. Preliminary efforts to place this plant in operation indicated the necessity of major design changes and the desirability of extensive research on a radically modified process. Recently such a process has been developed and put into operation with extremely gratifying results and enormous increases in the safety and efficiency of the operation.

13. The declassification of documents concerned with basic scientific data and techniques which could be released by the project under the provisions of the recommendations of the Tolman Committee has resulted in the release of about two hundred documents and a corresponding reentry of Los Alamos personnel into the scientific world. Approximately an equal number of documents are in process of release. Arrangements for cooperation with universities of the region with respect to the training of graduate students have been undertaken with satisfactory preliminary results and good expectations for the future.

14. The Manhattan Engineer District has realized the inadvisability, both from the point of view of our restricted facilities, and from the standpoint of their possible loss, of concentrating production activities relating to atomic weapons at this site. During the past year, the routine production of "standard" high explosive charges has been taken over by Salt Wells Plant of the Naval Ordnance Test Station at Inyokern, California. Plans are in progress to transfer the routine production of current type nuclear initiators to the Monsanto Chemical Company at Dayton, Ohio, and personnel to take

over this work are currently being trained at Los Alamos. The production of electric detonators is still continued at this site in view of the research aspects of the problem which still remain and which require pilot plant production facilities to solve. The production of active material into the required shapes has been maintained here since there are at present no other facilities in the country which can participate. We have also continued, for the time being, the production of normal uranium and aluminum parts associated with the active material in the weapon. The electronic components and mechanical components were largely stockpiled shortly after the close of the war and have represented only an inspection and modification burden upon the project personnel, with development being carried on by a subcontractor.

15. The Sandia Laboratory of this project, with increasing military participation, has taken cognizance of the stockpile storage problem, of the weapon assembly problem, the modification of stockpile parts, and the test and acceptance of components, other than nuclear or high explosive for the stockpile. In addition, this base has furnished the facilities for the limited amount of ordnance engineering development and tests of reliability which have been carried out by the project.

16. In retrospect, it is believed that the project has functioned reasonably well in fields which involve basic physics, chemistry, metallurgy, and high explosives. It has made progress in the design of nuclear components for weapons. It has not made satisfactory progress in the ordnance engineering of weapons. Administratively some progress has been made in employment practices for personnel; the payment of return travel expenses has been discontinued except for special cases; and property procedures have been modified to meet more nearly the requirements of peacetime practice. Insufficient research has been carried out directed towards establishing a basis for more satisfactory health safety practices for the special hazards affecting this type of work, although progress has been made in the routine administration of known tests and precautions. The practice of making critical assemblies has been discontinued until a remote control technique is available early in 1947. There has been inadequate integration of the community with respect to the relationships between the Technical Area and the Military Post. In spite of continued efforts by senior technical and senior military personnel, there remains an incompatibility or antagonism apparently impossible to overcome, resulting in a continual concern by the civilian technical personnel that the "Army will take over". The roots of this difficulty lie far in the past, and the problem itself may not be unique to Los Alamos.

17. Your Commission now faces the problem of determining the character and future directives of Los Alamos. Unfortunately, the local project is so small that the problems of the community bear upon the character of work done by the Technical Area, and reciprocally, the existence of the Technical Laboratory determines the existence of the community. While these problems can be discussed separately, their simultaneous successful solution is required for the success of either.

18. The Los Alamos Laboratory does not presume to indicate to the Commission what the policy of that body should be with respect to the national need for atomic weapon development. Nor should the laboratory as such express its views on the relationship of such a national program to the international scene. The discussion which follows is based upon the assumption that the United States will require, for an unknown time to come, a program in atomic weapon development and research. Such a program should be directed not only at maintaining an immediate superiority for the United States in this field, but towards maintaining general scientific progress and a concern for basic and long-range developments which will make for strength in the future. It is also assumed that the government of the United States must know what weapons might be arrayed against it for the proper formulation of its own national and international policies. The ensuing discussion is based in addition upon an assumption, which the laboratory can only suggest, that the Commission shares with the established armed forces of the United States a responsibility for the security and defense of the country; that the atomic weapon plays a fundamental role in any security program set up at this time; and that, therefore, the Commission and the Army and Navy are jointly concerned with this problem.

19. It has been noted that, up to the present time, the Los Alamos Laboratory has been responsible for the atomic weapon in its entirety. The atomic bomb has been employed by the armed forces exactly as received from Los Alamos and assembled with only Los Alamos personnel. There has remained, ever since the close of the war, concern as to the engineering reliability of the weapon as well as a conviction that engineering improvements were not only possible but desirable. The skepticism of the armed forces with respect to the ballistic determinations of Los Alamos personnel has already been apparent, and it may be anticipated that this feeling will grow to include the fusing and firing mechanisms and the complexity of weapon assembly. It is further noted that a demand is already apparent for weapons of somewhat different engineering properties -- e.g. a weapon which

will penetrate the surface of water and detonate at a pre-determined depth. Other requests from the armed forces including the guided missile investigators may be expected to appear shortly.

20. It is the belief of the senior technical personnel at Los Alamos that this laboratory should not attempt to carry out these purely ordnance engineering aspects of atomic weapon development. Conversely, it is strongly suggested that these problems should be handled using the Sandia Laboratory the existing ordnance facilities of the Army and Navy, as well as additional laboratories that may have to be set up.

21. It is suggested to your Commission that the Los Alamos Laboratory may be most effective if its concern is limited to the nuclear components of atomic weapons including, naturally, the technique of supercritical assembly of active material. The laboratory would then be expected to carry out research on both long-range and short-range modifications in the nuclear structure of atomic weapons, but would not be expected to present to ordnance engineering laboratories more than a functional design for a weapon with the exception of those parts intimately concerned with the nuclear reaction.

22. Such a division of responsibility will clearly call for the most active liaison between this laboratory and such other laboratories as are carrying out the engineering development. While such liaison will present problems, they are not believed to be insurmountable. To maintain the present philosophy and localized Los Alamos responsibility for complete weapon development will not only result in a practical strangulation of effort devoted to long-range research, but will curtail the responsibility of the armed forces in a problem in which they are presumably able and anxious to participate.

23. It is further suggested that Los Alamos retain the responsibility for testing the nuclear reactions for new atomic weapons, but that such tests as have a purely military significance be carried out by the armed forces. The distinction which is intended is that of separating a test of the "Alamogordo" type from a test of the "Crossroads" type. In view of the limited facilities of this laboratory, however, the most active assistance of the armed forces would be required in subsequent "Alamogordo"-type tests, but the directive responsibility would come from this laboratory.

24. There is attached herewith a statement of the laboratory program for 1947. Following the suggestion above, this project would be relieved of essentially all the program of the Weapon Engineering and Development

Division (Paragraph "F"). In its place would be formed a much smaller engineering group whose responsibility to the weapon program would be to represent this laboratory in its relation with the Sandia Laboratory or other agencies carrying out atomic ordnance engineering, and to prepare for such agencies the preliminary suggestions for the design of weapons having a different ordnance character. The Sandia satellite of Los Alamos would become an independent entity and would probably have to be considerably enlarged.

25. The problem of the "production" of atomic weapons has been considered above. It is believed that no immediate change can be made in the extent of the limited actual "production" carried out by Los Alamos. However, if the philosophy of maintaining Los Alamos as an atomic weapon research laboratory is carried out, it is suggested that plans be made to remove as much as possible of this routine activity from this site. This has the additional advantage of disseminating the knowledge of the necessary techniques as well as decreasing the seriousness to the nation of a major accident or catastrophe at Los Alamos.

26. A program of training regular military personnel in the assembly and component part testing of the current atomic weapons has already been instituted with personnel based at Sandia, but receiving the nuclear and high explosive phases of their indoctrination at Los Alamos. The Los Alamos Laboratory is no longer adequately staffed with personnel whose primary responsibility is the assembly of atomic weapons, although such assembly could probably be done in a grave national emergency.

27. The stockpiling and stockpile storage of atomic weapons is becoming a purely military responsibility for which the current headquarters are located at the Sandia Base.

28. It is probably true that the above activities in weapon research and development are by no means sufficient if this country is to engage actively in an atomic armament race with any hope of ultimate success. At the most such a program can hope to achieve only a temporary security; at the least it preserves a framework from which an expansion can occur if this becomes inevitable for the nation.

29. Up to the present time, this laboratory has not concerned itself with the application of nuclear energy to problems of military propulsion. Although the preliminary phases of such development fall within the experimental and theoretical background of Los Alamos, it is dubious if an adequate program could be carried out at this time without an expansion of the facilities of

both the laboratory and community. However, the character of the experimental research required by such a program, as well as its intermediate nature between a reactor and a nuclear explosion, suggests the possibility of ultimate participation in this field by the Los Alamos Laboratory.

30. The intimate relationship between the Los Alamos community and its technical activities has been mentioned above. During the war and the post-war year, this relationship has had a hybrid civilian-military character with the community considered as a rather unusual variety of Army Post. The exact character of the community status has varied with the dispositions and directives of the various Commanding Officers and the Director of the Laboratory. It cannot be said that there has ever been unanimity or complete satisfaction on this subject.

31. For many reasons, it is desired to suggest most earnestly to the Commission that they give the strongest consideration to operating Los Alamos -- if it is to be operated with approximately the above philosophy -- as a one-contractor civilian operation under the jurisdiction of the Commission and one or more of its Directors. We state with reluctance, but with conviction, that we do not believe that a continued Army operation of Los Alamos as a research laboratory and attached community will be successful. Nor do we believe that under Army operation it will retain or attract personnel adequate for the tasks facing it. Even the purely military guarding function will probably be better done ultimately with civilian guards.

32. The operation of Los Alamos as a "company town" in itself is characterized by a number of complications of which not the least arises from a general desire of personnel to own their homes and to be responsible through election and community taxation for the conditions under which they live. At the present time it is believed that these problems permit of solution, the accomplishment of which may be difficult and slow, but not beyond the powers of enlightened management.

33. Whether or not Los Alamos should be continued over a long period of time is doubtless a problem which will be considered by the Commission. This question has naturally received consideration here, and having received a tentative affirmative answer, has resulted in extensive programs of permanent construction. Many, but not all, of the activities proposed for this laboratory should not be conducted near populated areas. The isolation of the site represents certain community problem which is largely if not entirely balanced for personnel now here by the attractions of the climate and

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of the present mountainous location. The isolation of the technical community is more easily handled by a policy of encouraging attendance at national and regional scientific meetings, both of regular scientific societies and within the Manhattan District. The absence of railroad connections has contributed to a somewhat higher cost of transportation of materials to the project. Not a negligible factor involved in a proposed change of location is the fact that a large number of technical personnel have remained with the project because they and their families enjoy this location more than urban communities. It is hoped, should a new location be considered, that its advantages will be conspicuous.

34. Should the international situation develop to the point at which the United States may cease to have any concern for further weapon development or production, the Los Alamos Laboratory program would require careful reconsideration. Since, presumably, this is not a point at issue at the present time, it need not be considered here except to state that the operations involving plutonium, the basic chemistry and physics, the fast reactor, the large Van de Graaff accelerator, studies of materials at high temperatures, pressures, and radiation densities are all activities which will undoubtedly play a role in the peaceful applications of atomic energy no less important than the role which they play in a program whose objective is weapon research.

35. The above discussion in no sense deals with all the programs or problems of the laboratory, but it is believed that the major ones have been presented. The staff of the laboratory is, of course, deeply concerned with the attitude of the Commission with respect to these matters, and is, of course, available for any more detailed discussion which the Commission may desire.

Respectfully submitted,

N. E. Bradbury  
Director

NEB/b



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